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Thorp Gratings and Small Cameras in Eclipse Work.

By WILLIAM J. S. LOCKYER, M.A., PH.D.

THE total solar eclipse of August next will, no doubt, attract a large number of people away from these shores, and possibly the great majority will go armed with a kodak or some other form of small camera, in order to bring back a record of the corona.

It is unfortunately generally considered that the work accomplished with small cameras, that is, those having an aperture of about one inch, has no scientific value, because the employment of larger instruments by the numerous official parties gives all the information that is desired, and in a more efficient manner.

During the last few eclipses the small camera has demonstrated that it is capable of obtaining results which cannot be secured with instruments of large dimensions. Perhaps the first most notable instance of this is the success that was achieved in the photography of the coronal streamers. Thus, in the Indian eclipse of 1898, with lenses of $1\frac{1}{2}$ inches in diameter, and 9 inches focal length, Mrs. Maunder obtained a photograph of the corona, showing one streamer extending to a distance of 12.9 lunar radii from the moon's limb. At the same eclipse, a blue-jacket made exposures with the writer's camera (lens aperture 0.8 inches, focal length 8.8 inches) fixed on a stand, and, with an exposure of 15 seconds, obtained a picture showing one streamer extending to 10 lunar radii from the moon's limb.

A reproduction of this photograph is here shown (Fig. 1), but unfortunately the extensions are too delicate to be satisfactorily indicated.

The special object of the present article is, however, to draw the attention of those who will employ small cameras to the use of Thorp's replicas of Rowland gratings in connection with them. Not only can a picture of the corona be obtained, but *at the same time*, and *on the same plate*, the spectrum of the corona is also secured. This spectrum is in the form of rings, like that obtained with the prismatic cameras.

It may be said that the spectrum of the corona is obtained best with apparatus of large dimensions. This is true if the spectrum of the chromosphere be inferred, but in the case of the coronal rings, which are faint (with perhaps the exception of the green ring), there seems a great chance of small cameras rendering valuable assistance.

The main objects then of using these small instruments fitted with these gratings are to give us (*a*) long coronal streamers (if there be any), and (*b*) a record of the coronal rings. With this aim it is therefore best to be well within the shadow, as near to the central

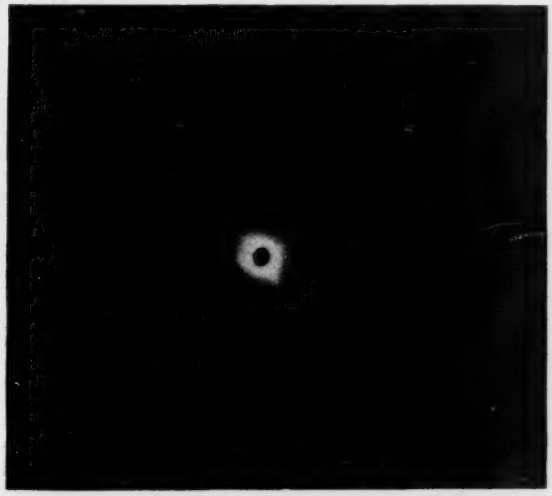

Fig. 1.—The Corona of the Eclipse of 1898 as photographed with a Zeiss lens of 0·8 inches aperture and 8·8 inches focal length. The planet Venus is seen in the right-hand bottom corner.

line as possible, and to commence the exposures some seconds after totality has begun, and finish the last exposure some five or ten seconds before the end of totality. This course is suggested to eliminate as far as possible the chances of photographing the chromospheric spectum, which might mask the coronal rings.

At the present time Thorp gratings can be procured in two sizes, the ruled surfaces covering an area of $1\frac{15}{16}$ by $1\frac{3}{8}$ and $\frac{15}{16}$ by $\frac{13}{16}$ inches respectively. The former are mounted on selected or worked glass $2\frac{1}{2}$ by 2 by $\frac{3}{16}$ inches in size, while the latter are placed on glass plates 2 by $1\frac{5}{8}$ by $\frac{3}{16}$ inches. The prices vary from fifteen shillings each to ten and even lower.

The grating should be fixed square on to the front of the camera lens with the lines of the grating in a

vertical plane. This is accomplished by making a small wooden frame, on the insides of which grooves are cut for the insertion of the grating. At the back of this frame a circular adapter is fixed so that the frame can be placed tightly on to the hood of the lens. It is advisable to make the frame and circular adapter as close fitting as possible, and to place the grating-side of the glass towards the lens, because the front lens should be as near to the grating as possible. A great advantage of the latter instruction is that the grating surface is protected from damage.

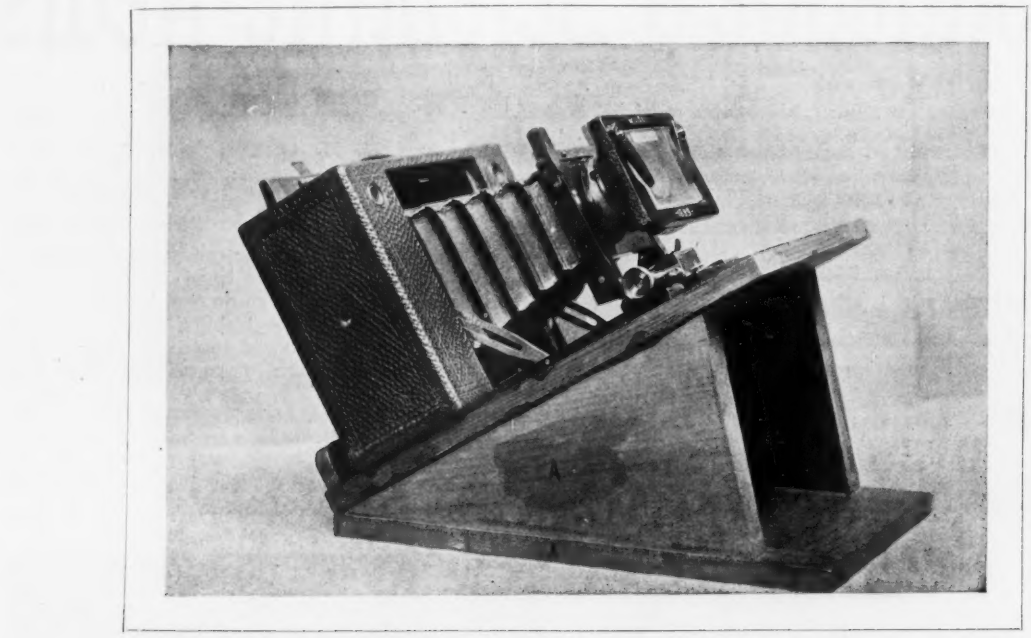

Fig. 2.—The grating attached to a 5 by 4 Kodak Camera.

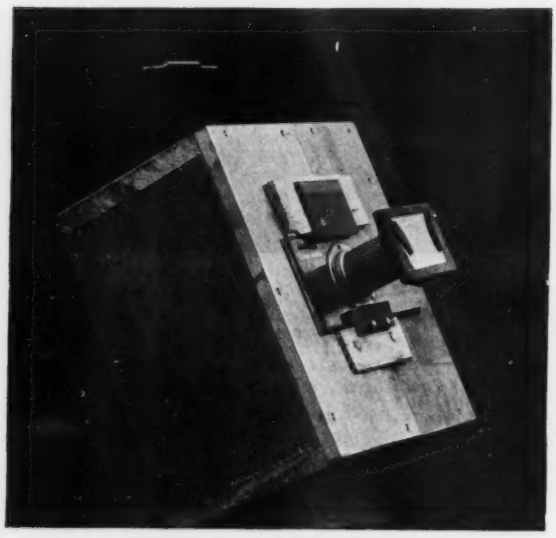

Fig. 3.—A rough home-made Camera with grating attached.

Such an adapter as above described is shown in the accompanying illustration. (Fig. 2). This shows a grating attached to a 5 by 4 Kodak, and experience has proved that the arrangement serves all practical purposes.

Those who possess more lenses than cameras can easily make a box-form of camera, the focussing being done either by moving the lens or by mounting the dark slide in a framework which moves in and out of the box. The accompanying figure (Fig. 3) illustrates a home-made camera, which has already done yeoman service on many occasions.

A camera fitted with a grating in the way above described when turned directly towards the sun shows an image of the sun in the centre of the ground glass, and a spectrum on each side of this image; these are the first order spectra given by the grating. Further away from the direct image still, and again on each side of it, will be found another spectrum, fainter, but

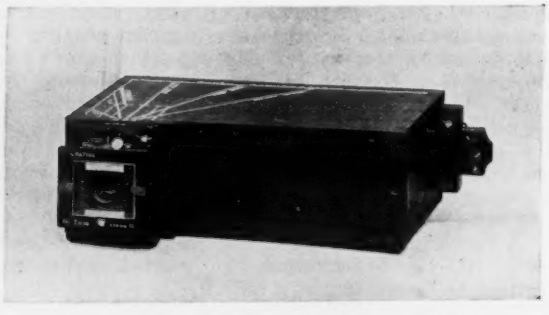

Fig. 4.—A perspective view of a box Camera, arranged to photograph the image of the Corona and the first and second order Spectra.

of greater length than the first; these are the second order spectra.

It may happen that the two spectra of the *first* order cannot both be made to fall on the ground glass, because the plate is not sufficiently large. In this case no attempt should be made to photograph both spectra; but the solar image should be moved a little to one side of the centre, and one of the spectra made to appear on the plate.

To take fuller advantage of the grating, especially on such an occasion as an eclipse of the sun, more enterprising observers can easily construct a special form of box camera. By this means both the corona and the first and second order spectra can be secured.

Such a camera as this is shown in the accompanying illustrations (Figs. 4 and 5), and was used with successful results in the Spanish eclipse of 1900. Even the form here given did not take the fullest advantage of the grating, because it was arranged only to photograph the direct image of the corona, and the two orders *on one side* of this image.

In the figures it will be noticed that the camera is constructed flat, the lines radiating from the lens (shown on the top of the box) indicating the directions of the incident light falling on the photographic plate. The thicker line on the right (Fig. 5) represents a diaphragm to cut off the reflections from the side of the box of the first and second order spectra that were on the photographic plate and so spoil the result. For such exposures, therefore, very fast plates should be used, and the spectrum plate is one to be recommended.

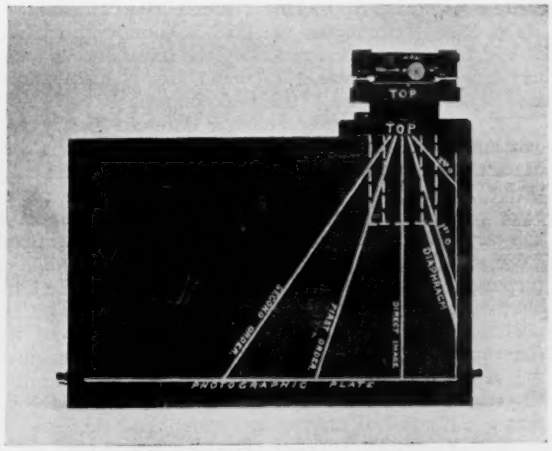

Fig. 5.—The same Camera as illustrated in Fig. 4, but seen from above. The white lines indicate the directions of the images of the Corona and the Spectra.

It is hoped that by employing gratings in this manner a new interest will be given to the user of small cameras, and that they will be rewarded with results that may prove of service to the cause of Solar Physics.

Fig. 6.—The Corona and first order Spectrum as photographed with the Camera shown in Figs. 4 and 5. Enlarged twice. Exposure 65 seconds.

not required. The focussing of the camera was accomplished by making the lens capable of being moved in and out of the box. It may be remarked that the grating in front of the lens makes no difference to the ordinary focal length of the lens, so that cameras which are focussed according to distance require simply to be set for infinity, as if an ordinary landscape was being taken.

Fig. 6 will, perhaps, give the reader some idea of the nature of the picture he will secure, but in this case only the first order spectrum has been reproduced. Owing to the fact that the solar light was thrown on to the grating by means of a siderostat, it was possible to give a long exposure to the eclipsed sun; for this example the exposure lasted 65 seconds.

Unfortunately, the plate was begun to be exposed before the chromosphere was covered by the moon, so that the spectrum in this instance is chiefly chromospheric. Nevertheless, the green ring forms a very conspicuous feature in the original negative.

In cases in which the camera is not equatorially mounted or used in connection with a siderostat, heliostat or coelostat, the exposures have to be restricted to about 20 seconds, otherwise the apparent movement of the sun would cause the image to change its position

The Action of Wood on Photographic Plates in the Dark.

By C. AINSWORTH MITCHELL, B.A. (OXON.), F.I.C.

SOME years ago Mr. T. C. Hepworth informed the writer that he had taken away some plates wrapped in dark paper in a wooden box, and that to his surprise many of them were "fogged" when unpacked a few days later. The phenomenon appeared inexplicable until in 1897 Dr. W. J. Russell showed that turpentine vapour had a pronounced darkening action upon a photographic plate, and in 1899 contributed a paper to the Royal Society in which it was shown that many other hydro-carbons, such as resins, had the same

property. The reduction of the silver was also found to be effected by vegetable substances with a strong odour, such as coffee, brandy, and linseed oil, which contain compounds, terpenes, allied to turpentine.

Dr. Russell attributed the phenomenon to the action of hydrogen peroxide formed by the oxidation of these terpenes in the presence of water (see "KNOWLEDGE AND SCIENTIFIC NEWS," this vol., p. 100).

Dr. Sperber, however, held a different theory and concluded from the results of a simple experiment that the action of the turpentine was due to photo-chemically active radiations. He found that when three plates were placed horizontally on a skeleton stand under a bell-jar with the bottom and middle plate film uppermost and the top plate film downwards, while a dish of turpentine was placed on the middle plate, all the films were completely blackened after four days. The experiment was now repeated with the position of the films reversed, so that the top plate was film upwards and the other two film downwards. In this case only the edges of the films were darkened, although the jar was equally full of turpentine vapour, and there would thus be the same possibility of chemical reduction. According to the radiation theory, only the edges of the plates in the second experiment would receive reflected rays from the wall of the bell-jar, whereas in the first experiment the rays would strike directly on the upper film and be reflected directly on to the lower films.

Last year Dr. von Aubel showed that various resinous substances could affect a photographic plate through black paper, but that the property was lost on heating the substance above its melting point.

Prior to this, experiments had been made by Mr. Hepworth and the writer to determine whether the "fogging" phenomenon mentioned above might not be due to the presence of resinous constituents of the wood, and it was found that many different kinds of wood possessed the property of so affecting a photographic plate in the dark that when developed in the usual manner a good impression of the section of wood was obtained.

Later in the year Dr. Russell communicated to the Royal Society the results of his very complete experiments on the same lines. He found that the impression was formed in 30 minutes to 18 hours, and that different kinds of wood showed great differences in their behaviour. Thus conifer woods were particularly active, as was also the case with oak, beech, Spanish chestnut, sycamore, and rosewood, while elm, ash, horse chestnut, and plane had but little action on the plate. But these relatively inactive woods could be rendered active by exposing them beforehand to sunlight or to blue rays, and this treatment also rendered the active woods still more active. Larch gave interesting pictures, the dark rings of the wood being active and the light rings inactive, while the reverse was the case with Scotch fir. The true bark of a tree and also the pith were found to be entirely inactive, but very old wood and bog wood had retained their activity.

In the present writer's experience very dry wood is less active than that which has been in a moist atmosphere. The effect produced by a piece of old very dry oak is shown in the accompanying figure. The piece of wood was left for several days on a Barnet medium plate enclosed in a well-fitting cardboard box in the dark room. As it had apparently had no effect, the experiment was repeated, and the plate developed after a year.

The print is interesting as showing certain features not seen in the beautiful pictures obtained by Dr. Russell. There is a curious halation round the edges of the wood which seems to indicate that the cross section of the grain is more active than the longitudinal section. It also shows that wood that is apparently inactive may give an impression if left for a very long period.

April, 1904, to April, 1905.
Oak left in contact with Photographic Plate in the dark for a year.

Herr G. Lunn has recently shown that a strawboard box is radio-active, the rays apparently proceeding from a number of points over the surface so that they form an irregular outline of an object placed upon a photographic plate in the box. The board becomes spent after an experiment, but recovers spontaneously if left to itself.

Here, again, it is probable that resinous substances are the active bodies, but further experiments are required to determine whether hydrogen peroxide is formed and plays the part of an intermediate agent in any of these phenomena.

A Bird-like Flying Machine.

By F. W. H. HUTCHINSON, M.A., B.CH. (CANTAB.).

(A Paper read before the Cambridge University Engineering Society.)

To those who have not given attention to the structure of a bird's wing, the following rough description may be of interest. The wing of a bird may be regarded as having two portions. (1) That part to the outer side of the wrist joint. The main feathers of this portion are usually about 10 in number and are known as the primary feathers. (2) That part to the inner side of the wrist joint which may be called the body of the wing. The main feathers of this portion vary according to the length of wing.

(*a.*) A salient characteristic of a bird's wing as a whole is the comparatively rigid and heavy anterior edge, and the light, yielding, elastic posterior margin.

(*b.*) If the primary feathers be examined carefully it will be seen that each one differs from its fellows, and that they differ in a graduated series. The quill is curved, and the feathered portion or penna is set round this in a helicoidal curve. Here, again, the portion anterior to the quill is stiff compared to the portion behind it.

(*c.*) Another characteristic of a bird's wing is that a fore and aft vertical section through the body of the wing discloses a curve somewhat of this shape.

Front. **Rear.**

This curve is more pronounced about mid-way between the wrist and the shoulder joint, *i.e.*, in the region of the elbow. When the wing is in the extended position for flight, this joint is distinctly behind the front edge of the wing. (Mr. Hargrave, of New South Wales, has devoted study to this curved portion, and it may, perhaps, be convenient to describe the curve as the Hargrave curve.)

Mr. E. P. Frost, of West Wratting, a well-known member of the Council of the Aëronautical Society of Great Britain, as a result of careful observation of the structure of natural wings of all kinds, and of the movements of wings in flight, came to the conclusion more than 20 years ago that for ordinary flight a wing is merely beaten up and down.

It is obvious that, owing to the yielding elastic posterior edge of a bird's wing, on the wing being beaten downwards both a lift and a drive is obtained.

It is also obvious that on the wing being elevated, a forward and downward resistance is evoked. (But the wing is so shaped that the down stroke must encounter greater air resistance than the up stroke, apart from considerations of the amount of energy put into the up and into the down stroke. Also the arrangement of the wing feathers causes a valvular action. Air passes through the body of the wing on the up stroke.)

Mr. Frost has contended that the result of the arrangement of the primaries must be that on being struck downward in the air, their ends travel forwards and upwards. In flight the wing tips of a bird (*e.g.*, a rook) can be seen to be curved upwards. If a shed primary feather be taken and held in its natural orientation and struck smartly down in the air the tip can be seen to spring markedly forward. Then the posterior edge of the penna becomes tense. But when the feather is not so stressed the posterior edge is sinuous and has a fullness. Other (normal) movements have been described, notably the so-called "figure of eight" curve generated by the movements of the wing tips; but Mr. Frost has contended that the movements of the wing tips in what may be considered normal steady flight are the automatic results of the peculiar construction of the wing and of its being beaten up and down against the air.

If during the down stroke the primary feathers are strained forward and upward within their elastic limits, it is obvious that energy is stored in them; and its restoration may in part occur even on the up stroke.

The curve (Fig. A) is taken from Marey's "Le vol des oiseaux," and the following description extracted from the text. It was photographically obtained, and shows the movements of a piece of white paper fixed to the tip of the first primary of a black crow. The crow was caused to fly in front of a dark screen, and the lens exposed during five beats of the wings. The curve shows only the trajectory of the white paper; and Marey directs attention to the increase of distance between successive loops due to the increasing mean velocity of the bird.

The recurving at the bottom of the loops would seem

Direction of Flight. <——

Fig. B.—Trajectory of Bird's Wing.

to be due to the restoration of energy from the forward stressed feather. (The portion which the present writer ventures to indicate between the lines k and k' seems to be from just before the commencement of the down stroke to the commencement of the next.)

The curve (Fig. B) was recently obtained by Major

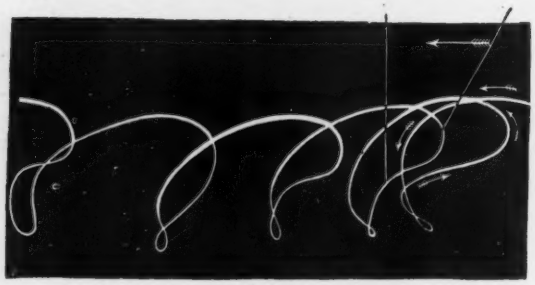

Fig. A.

B. Baden-Powell in the following way: Small birds were procured, and tubes of paper were prepared, whose internal diameters were approximately the distance between the tips of the outstretched wings of these birds. The internal surfaces of the tubes were covered with a coating of lampblack. A tube was then arranged with one end in a room and the other end pointing out of doors through an open window, and a bird liberated within the inner end of the tube. As it flew out towards the light a record of the movements of the wing tips was obtained by the tips of the feathers scratching off the lampblack. Several observations were made, a fresh tube being used each time. On page 121 is a reproduction of one of the actual records (reduced in size).

Major Baden-Powell considers these marks to represent the down stroke, and the light scratchings seem to show that the wing is flexed on the up stroke.

The writer ventures to think that the difference in the distinctness between the two portions is due to the wrist being in a slightly flexed condition on the up stroke in what may be considered the normal position, and that on the down stroke the stressing of the primaries automatically increases the distance between the wing tips and opens the wrist automatically against its elastic re-action. The wing *as a whole* is essentially an elastic structure. The absence of recurvation at the lower portions of the record taken in conjunction with the form of the down stroke record, would seem to show that (being in the tube) the bird was not flapping at full vigour, or quite normally, and that the stored energy of the primaries was given out during the latter part of the down stroke.

During flapping flight the primary feathers automatically exert a clawing swimming action.

In reference to the Hargrave curve, Mr. Hargrave has demonstrated that when air is blown against such a curved surface—thus

—a lift is obtained against the bight of the curve. He arranged little trap-doors opening upwards, which

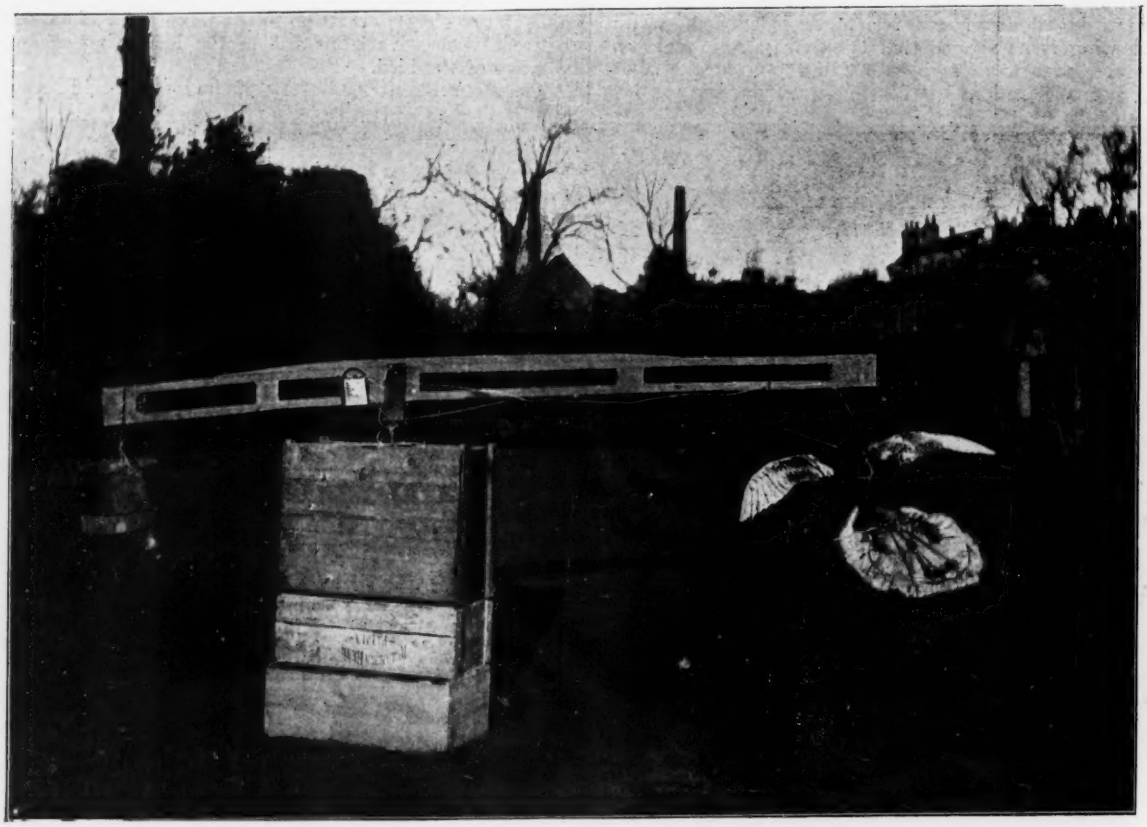

Fig. 1.

opened under the influence of an air current as shown by the arrow.

This is doubtless due to the formation of eddies by the air flowing over the rigid lip.

It is obvious that a bird's wing both as a gliding and a propelling surface is a beautifully efficient instrument.

To test these views, in 1902, Mr. Frost and the writer, with the co-operation of Mr. C. R. D'Esterre, arranged the apparatus shown in Fig. 1. A pair of dried natural wings (area about three square feet) were arranged with a small electric motor and a reduction gear to flap up and down, the arrangement being suspended by a spring balance from the balanced arm. The best result was obtained as hereunder :—

Volts.	Amps.	Estimated H.P. on Wings.	Estimated loss in Motor and Gear Transmission.	No. of Flaps per minute.	Maximum Lift.
24	12	$\frac{1}{10}$	75%	350 to 400	5 lbs.

The effect was striking. The "bird" flapped itself round and round, although it fell between the down strokes. But against this must be set the fact that its rate of progression was only four or five miles an hour, no doubt owing to air resistance and friction, which were considerable, for the apparatus was crude. Also the "bird" weighed about 21 lbs., which would, of course, pull it down on the up strokes. The oscillations to a marked extent diminished after the tail was fitted.

It will be noted that the ratio of h.p. to lift was 1 h.p. to 50 lbs. This ratio tallies with that given by various authorities as that obtaining with birds, and is not in marked contrast with the ratio obtained (according to published reports) with the large machine of Messrs. Wright in U.S.A.

One may describe a flying lift and a hovering lift.

The hovering lift obtained in a confined space, and only three feet above the floor with the figure 1 apparatus with 1 h.p. gave a lift of 10 lbs.

We considered we had justification for proceeding with a larger model. This has been constructed and partly tested and Figs. 2 and 3 show it on the rough carriage.

It is intended to run this car on a special trough

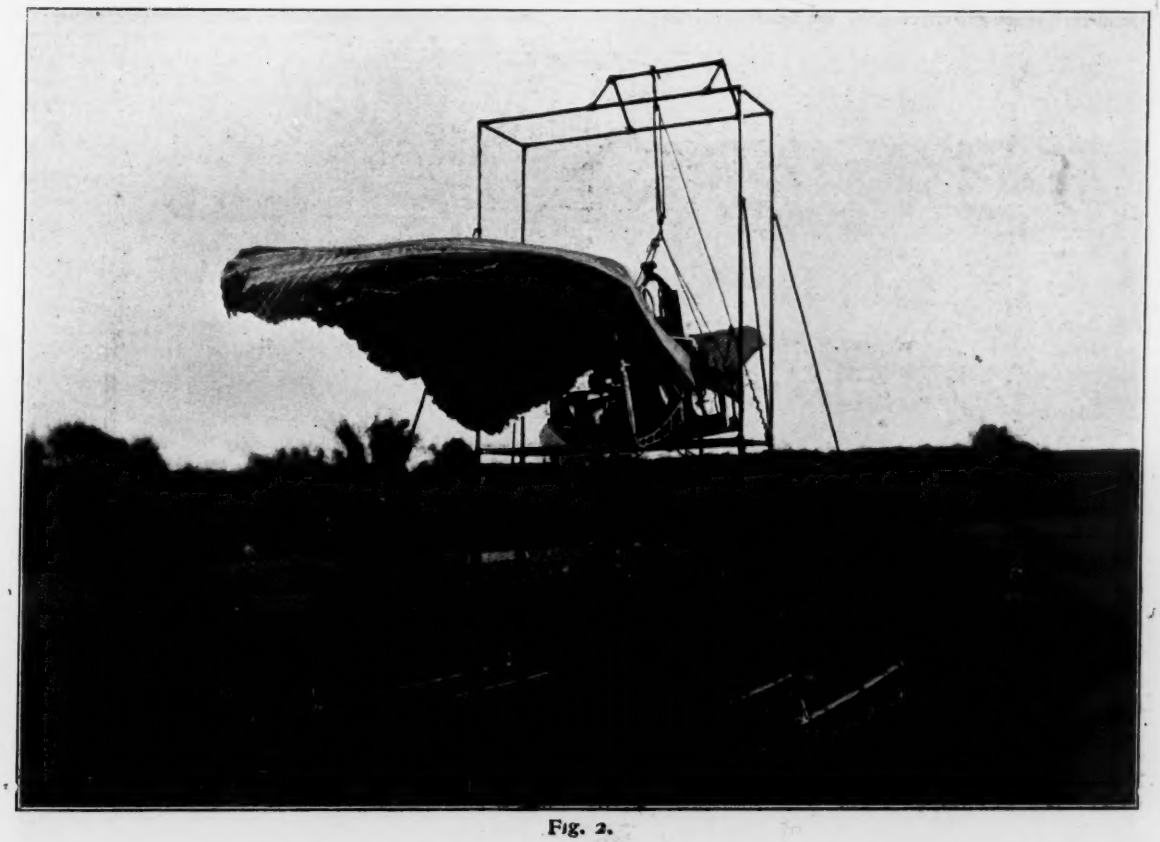

Fig. 2.

section track, and to arrange in the frame 4 vertical guides, one at each corner, of stretched cord or wire.

The machine will be suspended from a spring balance. The model has certain crudities in the motive portion, although the workmanship (which, apart from the wings, was carefully carried out by Messrs. Pye, scientific instrument makers, of Cambridge, and the Cambridge Autocar Co., Ltd.) is good. But it is a testing model only, and is merely intended to obtain data from.

The wings are of special construction, designed in accordance with the above enunciated principles. The total wing area is about 20 times that of the No. 1 model (*i.e.*, about 60 square feet). The machine measures about 20 feet across.

The transmission is by coned friction clutch, and chains in two stages, to connecting rod. The crank throw is adjustable for altering the size of angle of

flap. The top sprocket of second motion can be raised or lowered for altering the limiting positions of the wings (*i.e.*, the position of the arc). The lower end of the connecting rod actuates the inner ends of the levers for wagging the wings by a simple device of two oscillating roller-carrying links attached to the cross head, whose pin is constrained by vertical guides.

To the brackets, seen below the wings, are attached "pectoral cords" of elastic. These store up energy on the up stroke, and so obviate too violent alternations of load on the driving mechanism.

The motor is a nominal 3 to 3½ h.p. petrol cycle-engine.

The wings are at present arranged to flap 100 times a minute, which is, of course, considerably less than

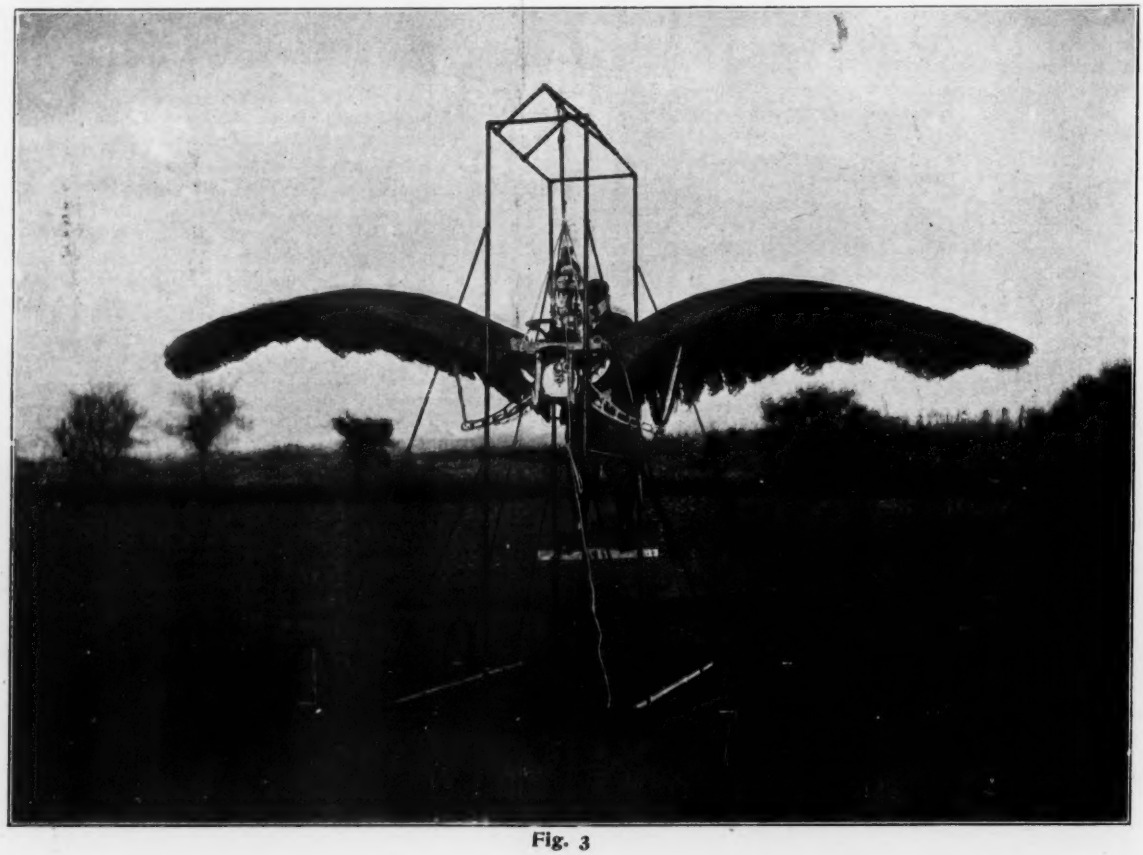

Fig. 3

proportionately corresponding to the increased area and h.p. But increased area does not imply proportionally increased resistance.

The machine has been suspended from a tree bough, and the wings flapped under power. The results are very promising. At each down stroke the whole machine, apart from the carriage, weighing 232 lbs., is lifted up bodily into the air and forwards. It rises about two feet each stroke. It looks just like a gigantic bird trying to fly under similar conditions. At the down strokes the suspending rope leaves the vertical and becomes markedly inclined. The pull on the rope then pulls the machine back, so that even if it be capable of flight it cannot fly under these conditions. At the down stroke it seems that, if the rope were then severed, the machine would travel up and away with the powerful sweep of the wings. The spring balance reading is here obviously fallacious so far as registering the lift goes, because the rope is pulling the machine back. However, at the rough tests so far made, the balance shows a diminution of reading of 80 and 160 lbs. at the down stroke when the machine springs upwards but also forwards.

At the preliminary trial already made the wings described a diminished angle to that of the No. 1 model.

It should be noted that with this angle and 100 flaps per minute the wings appear capable of evoking a resistance of about 100 lbs. each, and the machine is raised about two feet at each stroke. It is difficult at present to form a correct idea of the position of centre of pressure, but we think that it goes through an arc of 2.25 feet on the down stroke.

In the model, which is susceptible of considerable lightening, we have nearly 33 square inches per lb.

There are grounds for believing that a feathered wing made of a number of units can exert a greater resistance than a simple wing; such as that of the insect or bat type, or the various simple mechanical wings which have been hitherto used in wing flapping machines. There are experimental grounds for believing that resistance is more dependent on periphery of an aëroplane than on its superficial extent.

Furthermore, the primary feathers must certainly act as a series of stepped aëroplanes, each acting on air from a different level which has *not* had a downward velocity imparted to it by having had to sustain the weight of a previously acting supporting surface.

The Nature of Life.

By GEOFFREY MARTIN, B.Sc. (LOND.).

I.

[This interesting paper, by Mr. Martin, opens up some new conceptions regarding the nature and origin of life.

In the first part the author commences by explaining how all chemical compounds decompose at a certain critical temperature and pressure, and how the number and kind of atoms in the molecule decide the degree of temperature. He then discusses what would be the composition and properties of a substance whose critical temperature and pressure coincide with those now prevailing on the earth's surface, and he comes to the conclusion that living protoplasm possesses in every respect the properties of such a compound. He then develops this idea. Some parts of the protoplasm decompose somewhat more rapidly than other parts, and, corresponding more sensitively to certain influences, thus develop into different organs.

In the second part (to be published next month), it is suggested that since the temperature of the world's surface was in former times very different to that which now prevails, the modern protoplasm is simply the product of evolution of older kinds of protoplasm, living at high temperatures, in which heavier elements, such as silicon, phosphorus, sulphur, &c., replaced the lighter elements which now principally compose it.

In a third part, future developments are discussed.—ED.]

IF we place a given chemical compound (say $CaCO_3$) in a closed cylinder and subject it to a continually increasing temperature, keeping the pressure constant by means of the piston, then at a certain temperature range the compound begins to decompose. If, now, we increase the pressure sufficiently, the decomposition ceases and the substance can now bear a higher temperature than before without decomposing. Proceeding in this way, it is obvious from the finite nature of the mass of the atoms, and from the limited intensity of the forces holding them together in the molecule, that ultimately at some definite temperature the external forces tending to drive the atoms apart will become equal to the maximum internal forces that the atoms *can exert* on each other in the molecule. It is, therefore, obvious that above a certain definite temperature, depending upon the nature of the molecule, *no pressure, however great, can prevent the substance from completely decomposing*. This temperature and pressure, above which a compound is incapable of existing, we will call the *critical temperature and pressure of decomposition* of the compound.

The critical temperature of decomposition would, therefore, be completely analogous to the critical temperature of liquefaction of a compound—only in the latter case we are dealing with the temperature whereat a certain *molecular* condition of existence disappears; and in the former case with the temperature whereat a certain *atomic* condition of existence disappears.

Since atoms are a very much more finely divided form of matter than molecules, it is clear that the critical temperature of decomposition of a compound must be a very much sharper and clear-cut constant than its critical temperature of liquefaction.

The critical temperature and pressure of decomposition of even very unstable compounds is usually very high. For example, although $AuCl_3$ is almost completely decomposed at about 200°, yet Rose's experiments show* that it is capable of existing in traces at very high temperatures indeed. Cyanogen, ozone, and the oxides of nitrogen, although very unstable at ordinary temperatures, seem capable of existing at excessively high temperatures.

* *Jr. Chem. Soc.* (1895) 67. 881.

In general, the smaller the number of atoms in the molecule of a compound, the higher is its critical temperature of decomposition; whereas the greater the number of atoms, the lower the critical temperature. The reason of this is, of course, due to the general fact that the more atoms there are added on to a molecule, the feebler is the intensity of the forces holding the atoms together in the molecule—as is evident from the general observation that the more complex a compound is, the more easily decomposable it is.

If, now, by some means or other we proceed to steadily add on atoms to a molecule so as to make it more and more complex, we steadily lower its critical temperature of decomposition. And by adding on a suitable number and kind of atoms, we could reduce the critical temperature and pressure of the compound until they *coincided with the normal temperatures and pressures which hold upon the earth's surface.*

Such a compound would be possessed of an extraordinary sensitiveness to external influences on account of the sharpness of the constants called above the critical temperature and pressure of the compound. A slight increase of temperature, or a slight decrease of pressure, would serve to throw it into a condition of rapid chemical decomposition; whereas a slight increase of pressure and decrease of temperature would cause the substance to suddenly cease to decompose; and even did we maintain the external temperature and pressure *exactly* at the critical temperature and pressure of the compound, nevertheless, the external impulses which are continuously pervading all space in the neighbourhood of the solar system, beating intermittently upon the sensitive substance, would alone be sufficient to throw it into a series of rapidly alternating states of decomposition and repose.

In order to generate such a complex compound, we must first take as the central atom an atom capable of exerting a high grade of valence, and possessing a well-developed power of self-combination. The high valency grade of the central atom is necessary in order that we may be able to add on to it atoms of different natures so as to regulate precisely the stability of the resulting compound; and the power of self-combination is advisable in order that the molecule may be of the necessary grade of complexity, so as to reduce its critical temperature and pressure of decomposition exactly to the temperature and pressure which hold upon the earth's surface. The atoms added on to the central atom must possess a small but perceptible affinity for the atom and for themselves.

What known elements, therefore, would be most suitable to enter into the structure of such a compound? A study of the elements will convince the reader that the element of high valency grade which possesses the power of self-combination (and, therefore, the possibility of generating complex compounds) most highly developed is carbon; and the five elements most abundant upon the earth, which possess a small but quite definite mutual affinity for carbon and for themselves, are hydrogen, oxygen, and nitrogen, and in a lesser degree sulphur and phosphorus.

We should expect, therefore, to find such a complex compound to be composed chiefly out of carbon, hydrogen, oxygen, nitrogen, and containing small amounts of sulphur and phosphorus. Our conclusion is confirmed when we come to survey the nature of the

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complex compounds containing carbon, hydrogen, oxygen, and nitrogen—namely, the proteids. We find that they are almost invariably characterised by their feeble stability, and have undoubtedly a comparatively low critical temperature of decomposition. So feeble, indeed, is the general affinity of carbon for hydrogen, oxygen, and nitrogen, that at a red heat the whole of organic chemistry is destroyed.

From the facts discussed in my work, "Researches on the Affinities of the Elements," chap. II., pp. 120-123, it is probable that such a compound would have definite physical characters. For since its atoms attract each other but feebly, the molecules would also attract each other but feebly. It would, therefore, be either of a fluid or semi-fluid nature, and soft. Because its molecules are very great it would not be volatile. Does such a compound exist? I believe so, the compound being nothing more nor less than the protoplasm which forms the basis of living matter. All its chemical and physical characteristics agree with what we should have expected. It is formed out of the four elements, carbon, hydrogen, oxygen, and nitrogen, with small amounts of phosphorus and sulphur; it is of a semi-fluid and soft nature; it is in a state of continual and intermittent change so long as life continues; the temperature of living matter keeps remarkably constant, precisely as it should do on our supposition—a temperature too high exceeding its critical temperature of decomposition and thus destroying its structure, while a temperature too low causes it to cease to decompose and the living matter becomes inactive.

The temperature range of animal life, then, is probably nothing more nor less than the range of the critical temperatures of decomposition of a certain series of very complex carbon compounds grouped together under the name "protoplasm." The external pressure of the atmosphere coincides roughly with the critical pressures of decomposition.

The incessant varying in the external conditions of temperature and pressure, and the external influences, such as radiation and light, which are continually beating upon the earth from external space, are thus the cause of the continuous change characteristic of living matter. In fact, just as a tuning fork is set into motion by vibrations of a certain definite frequency, and by no others, so living matter is so constructed as to respond continuously to the incessant minute fluctuations in the external conditions which hold upon the earth, the state of response being what is known as life.

The difference in the functioning of the different parts of the protoplasm (which exhibits itself in the tendency to produce different organs) is probably due to the different sensitiveness of the different sorts of protoplasm to different specific external influences. Such a differentiation in the nature of the protoplasm in the different organs is probably brought about by the substitution of minute quantities of light or heavy elements for the other elements in its structure. Such a substitution alters to a slight extent the critical temperature of decomposition of the protoplasm, and thus makes it more or less sensitive to certain specific external influences according to specific needs. This probably explains why certain specific heavy elements are retained in considerable quantities in certain organs, and are almost entirely absent from other organs. The different modes of action of the protoplasm are thus probably due solely to the different critical temperatures and pressures of certain parts of the protoplasm.

(To be continued.)

The Conservation of Mass.

By ALFRED W. PORTER, B.Sc.
Fellow of, and Assistant Professor of Physics in, University College, London.

(Continued from December, 1904.)

II.

IN the first part emphasis was placed on the fact that an ordinary balance compares two forces with one another—viz., the *weights* of two bodies—and that the weight of a body is not a satisfactory measure of the amount of stuff in it, because the weight varies from place to place. We further defined another quantity—the *mass* of the body—which was asserted to be a constant for the same body under all conditions. It is our intention now to show that a relation exists between these quantities. For, in fact, the weight of a body is only another term for the action between the body and the earth. These are two bodies which change each other's motion by their mutual influence. The motion of the earth produced by a falling stone is, indeed, too small to be directly observed; and, moreover, as we are on the earth, and move with it, it would in any case be liable to escape our observation. But we nevertheless do not doubt that this case falls in with the general rule that every action is accompanied by an equal but opposite reaction.

If we take this for granted, we may write down an equation for the earth and stone similar to that between the inter-acting billiard balls:—

$$\frac{\text{Mass of stone}}{\text{Mass of earth}} = \frac{\text{increase in velocity of earth.}}{\text{decrease in velocity of stone.}}$$

The time during which the change is observed may be any whatever; but it will be most convenient to refer to the changes in velocity that take place in unit time—that is, to the rate of increase, which is called the *acceleration*. Denoting the masses of stone and earth by the letters m and E, and the accelerations by a and g, the equation becomes

$$\frac{m}{E} = -\frac{a}{g}$$

which may be written

$$mg = -Ea.$$

It is this product which measures the action between the two bodies; mg is the action of the earth on the stone—*i.e.*, its *weight*—whereas $-Ea$ is the opposite and equal reaction of the stone on the earth. The connection between *weight* and *mass* is that the former is the latter multiplied by g (the acceleration while falling freely). Now all experiment goes to show that when disturbing causes are eliminated, all bodies have the same acceleration in the same locality; so that with this restriction as to locality, weight and mass are proportional to one another. On the other hand, the relation between the two is different even for the same body when the locality is changed. For the sake of clearness think of one body alone. In any particular locality it has a certain weight, a certain mass, and a definite acceleration under the action of the earth's pull. In another locality it conceivably has a different weight, mass, and acceleration. In each locality these three quantities are not independent of one another, but are related by the equation—

$$\text{Weight} = \text{mass} \times g.$$

And the important question to which an answer must be given is—Can we account for the variation in weight by the variation in g alone, without supposing the mass to vary, or is the mass also subject to variation?

Or again, we take the same substance in a definite locality, but in more than one chemical state, *e.g.*, iodine and silver, at first uncombined and then in the state of combination. The questions to be asked are: Is the weight conserved during the reaction? Is the mass conserved? Is the acceleration *g* conserved?

The question to which most attention has been given, though not always with a clear perception of the issues, is, Does chemical change influence weight?

It is easy to produce a chemical transformation in a closed vessel, and tolerably easy to test on a balance the weight of the contents both before and after the action. Measures were made to this end in 1893 by Landolt on (amongst other things) the combination of silver with iodine, but with uncertain result. Later investigations made by him (in 1900) on the transformation of a ferrous into a ferric salt, in which the clearest evidence of apparent weight was obtained, are unfortunately complicated by the fact that there is here a change also in the magnetic properties. A piece of iron placed in a magnetic field becomes magnetised, and tends to move in it unless the field is quite uniform. Any variation of its magnetism due to a change of its magnetic permeability would entail a corresponding change in the pull from magnetic causes; and this action might conceivably be the cause of the apparent change in weight. Besides, there might be a more direct connection between magnetism and gravity, so that change in one necessarily provoked a change in the other, whether the magnetic field were uniform or not. It is interesting to be reminded that Faraday in 1850 had sought for a connection between electro-magnetism and gravity. He had a "long and constant persuasion that all the forces of Nature are mutually dependent" and although his experiments led to a negative conclusion, yet the results did not shake his "strong feeling of a relation between gravity and electricity, though they give no proof that such a relation exists." Leaving aside some unsatisfactory experiments of Sanford and Ray in America this was the state of affairs in 1901 when Heydweiller, of Breslau, published in "Drude's Annalen" the results of a series of experiments. These were made with every precaution, employing a variety of reactions; and in every case but two a diminution of weight was found to have occurred during the chemical change. The total weight of reacting substance varied from 160 to 280 grammes, and the alteration in weight amounted in one case to more than one-fifth of a gramme. Excluding all those cases in which the observed change did not exceed, or barely exceeded, the expected errors inevitable to the experiments, Heydweiller considers that an alteration of weight has been safely established as taking place (*a*) when iron reacts on alkaline or acid (but not neutral) copper sulphate solution, (*b*) during the solution of acidified copper sulphate in water, and (*c*) during the action of caustic potash on copper sulphate. No conclusion could be arrived at as to the dependence of the change upon the amount of action taking place. Nor does there seem to be any obvious reason why alkaline and acid solutions should exhibit a different behaviour from a neutral one if the change in apparent weight is in reality due to an alteration in gravitational pull. It should be observed that the reactions employed are only mild ones. The impossibility of employing more vigorous ones arises from the necessity of preventing any action from taking place until after the first weighing. The transformation took place in an inverted U-tube, each limb at first containing one of the substances that were afterwards to be mixed. And, indeed, Lord Rayleigh has pointed out that a possible source of error in the experiments is that, even with the materials actually used, some change may have been progressing during the first weighing. If, for example, copper sulphate is in one limb and water in the other, there will not be complete equilibrium; water will distil over to the salt, and although this motion will not directly modify the pull on the balance, since the forces called into play are internal forces, yet thermal change will accompany the evaporation and condensation of the water (the limb containing the water will cool and the other will rise in temperature), and the difference of temperature thereby set up will interfere with the accuracy of weighing owing to the convection currents that it will produce. It must be remembered that the effect observed is only small, and although every endeavour was made to exclude possible sources of error, it must be admitted that the results form a very precarious foundation for theory. The evidence would be strengthened if there were some degree of regularity in the amount of the change; but no regularity exists apart from the fact that the change is negative in all the cases in which it is greater than the expected error. The magnitude of the change observed is well within the powers of a good balance to demonstrate; there is therefore every reason to hope that by the accumulation of evidence all doubt will eventually be removed.

It would be of great theoretic importance to learn that some change does really occur. At present, gravitation is somewhat of a stumbling-block from the point of view of theory. It is so indifferent to circumstances. How is it that the earth pulls a body with sensibly the same force whether a plank (say) is interposed or not? What is the nature of this tie between the two bodies which is not severed thereby? It is true that by inserting a plate of a magnetically indifferent body like copper between two magnets the attraction (or repulsion) between them is not modified. But in what sense can we regard a plank as being gravitationally indifferent? Again, it has recently been shown by Poynting that the pull on a crystal such as quartz, which is a substance that in most respects exhibits different physical properties in different directions, does not sensibly depend upon the orientation of it with respect to the earth. Whether it will turn out or not that the ether is the medium concerned with the transmission of gravity, it is clear that the propagation takes place in practical independence of the structure of the matter through which it passes. From the general physical behaviour of bodies, therefore, it is not to be expected that any modification should be brought about by chemical change which, as far as we know, simply consists in a re-arrangement of the finer parts of which a substance is composed. Any modification, then, which may eventually be demonstrated to take place will introduce a new element into the theoretic consideration of gravity. It will indicate that, from the point of view of this question, the nature of the changes which are dealt with in chemistry are of an essentially different type from the coarser changes which are termed physical. Mixing two substances together may not change their weight, and, in view of Poynting's experiment, we do not expect that it will; but bring about the more intimate chemical union, and the grip of the earth on the body may have changed. The knowledge gained by the final settlement of this question will affect not only gravitational theory, but will have to be taken account of also in the consideration of the exact nature of the forces which come into play in chemical change. On the other hand, if it should turn out that the variations found by Heydweiller are due to unsuspected sources of error, there will be no fact known connecting gravitation with any other physical property of matter.

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Although the question of the alteration in weight is not yet settled, it is not premature to consider what is involved in the acceptance of it. We have seen that it is bound up with other questions. Its acceptance involves that there shall also be a change in the mass of the body or in its free acceleration under gravity, or in both. Not long ago a possibility of the change in the mass of a body would not have been considered even except with great reluctance. The constancy of mass has been one of the fundamental tenets of the creators of the present state of physical science. Physicists of the Nineteenth Century would have turned with preference to the alternative possibility. We shall consider these points in the next part in connection with the electrical origin of mass.

(To be continued.)

Star Map.—No. 2.

Pegasus, Andromeda, and Pisces.

As regards the general configuration of stars, the chief feature included in the present map is the "Square of Pegasus" (although, be it remembered, one of the stars is not in Pegasus). This will be easily recognised near the centre of the map, and in the actual heavens is a ready means of determining the true North. At the top of the map is the greater portion of Cassiopeia, which constellation is included complete in Map I.

One of the most remarkable objects within this region is the Great Nebula in Andromeda (R.A. oh. 38m. Dec. 40° 45′ N.), one of the few visible to the naked eye. This was the first nebula noted, having been described long before telescopes were invented. It is of elliptical shape, and when viewed in a powerful telescope it seems to consist of a number of rings with bright centre, presenting an appearance somewhat similar to a hazy view of Saturn. The spectrum of this nebula is continuous, and would therefore be that derived from a large number of stars of different compositions. Hence it has been inferred that this object may be in reality a vast group of very distant stars, and not a gaseous nebula. In 1885 a "Nova" burst forth in this nebula.

γ *Andromedæ* (1. h. 5m. + 41° 51′) is a fine triple star. Two stars, magnitude 2½ yellow, and 5½ blue green, are at a distance of 10″·2, and the latter seen in a powerful telescope resolves itself into a binary at a distance of 0″·45. Near this another peculiar nebula of very elongated form occurs.

α, η, *and* σ *Cassiopeiæ*, as well as δ *Cephei*, are double stars, the first and last named being also variables which have already been referred to in the description of Map I.

γ *Arietis* (I. h. 48m. + 18° 49′) is one of the earliest discovered double stars, magnitude 4·2 and 4·4, distance 8″·3.

ι *Trianguli* (II. h. 7m. + 29° 50′) is a double star, one 5th magnitude yellow, the other 7th magnitude blue. Distance 3″·5.

μ *Cygni* (XXI. h. 40m. + 28° 18′) is a double star, of 4th and 5th magnitudes. Distance 2″·6

ζ *Aquarii* (XXII. h. 24m. − 0° 32′), double star, both of 4th magnitude. Distance 3″·1.

(Star Map No. 1 (North Polar Regions) appeared in the May number.)

The Nation's Latest Acquisition.

By W. P. PYCRAFT, A.L.S., F.Z.S., &c.

"THERE are no examples of *Diplodocus* at present in the collection." Such is the statement to be found in the Guide to the Geological Galleries of the British Museum. To-day, thanks to the generosity of Mr. Carnegie, this gap has been filled by the splendid gift of a replica of the magnificent specimen of this enormous creature in the Carnegie Museum at Pittsburg. Since the Dinosaurs hold so important a place among the reptiles, a short account of the remarkable specimen just added to our National Natural History treasure-house may be of interest to many readers of "KNOWLEDGE."

Diplodocus Carnegii, as this specimen has been named, represents one of the largest land animals known, measuring some eighty-four feet from tip of snout to tip of tail, and between thirteen and fourteen feet high at the top of the haunches. Of this enormous length, over fifty feet belong to the tail, and about twenty to the neck. Apart from its great length, the vertebral column is remarkable in several particulars. The neck vertebræ, fifteen in number, recall those of birds, in their great pneumaticity, as well as in the shape and disposition of the cervical ribs. The neural spines of the thoracic vertebræ are of great height, as one would expect from the great length of the neck. But the caudals, perhaps, are the most interesting. These taper rapidly, terminating eventually in a number of long cylindrical vertebræ forming a whip-like termination to this appendage. Whether this peculiarity is the result of degeneration, or whether of specialization to some peculiar function, is not known, but the former is probably the case. At the place where the tail first rests upon the ground two separate sets of two vertebræ each are found to be firmly fused together. Prof. Osborn suggests that this fusion is the result of mechanical strain brought about by the use of the tail to form a tripod, inasmuch as this beast, he believes, was in the habit of rearing itself upon its hind legs, after the fashion of a kangaroo. An examination of these vertebræ, however, rather seems to show that this fusion is the result of injury. The whole aspect of the animal seems to contradict the possibility of any such acrobatic feats as standing erect.

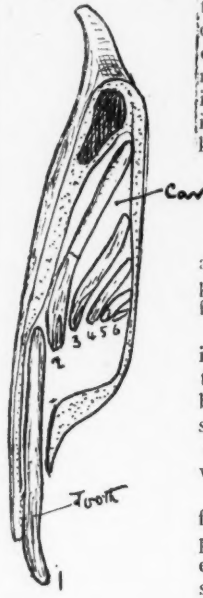

Fig. 1.—Section of upper jaw of Diplodocus to show the succession of the teeth.

The pillar-shaped legs terminated in five short, stout toes, of which the three innermost on each foot bore large claws, which, it is significant to note, are twisted outwardly. The outermost digits were clawless.

The skull, which was about two feet in length, is curiously flattened, presents a rounded muzzle, and an extraordinarily small brain cavity; so small, that the brain has been described as scarcely larger than a large walnut! Teeth were confined to the fore part of the jaws,

MAP No. 2.

MAP No. 2.

Pegasus, Andromeda, and Pisces.

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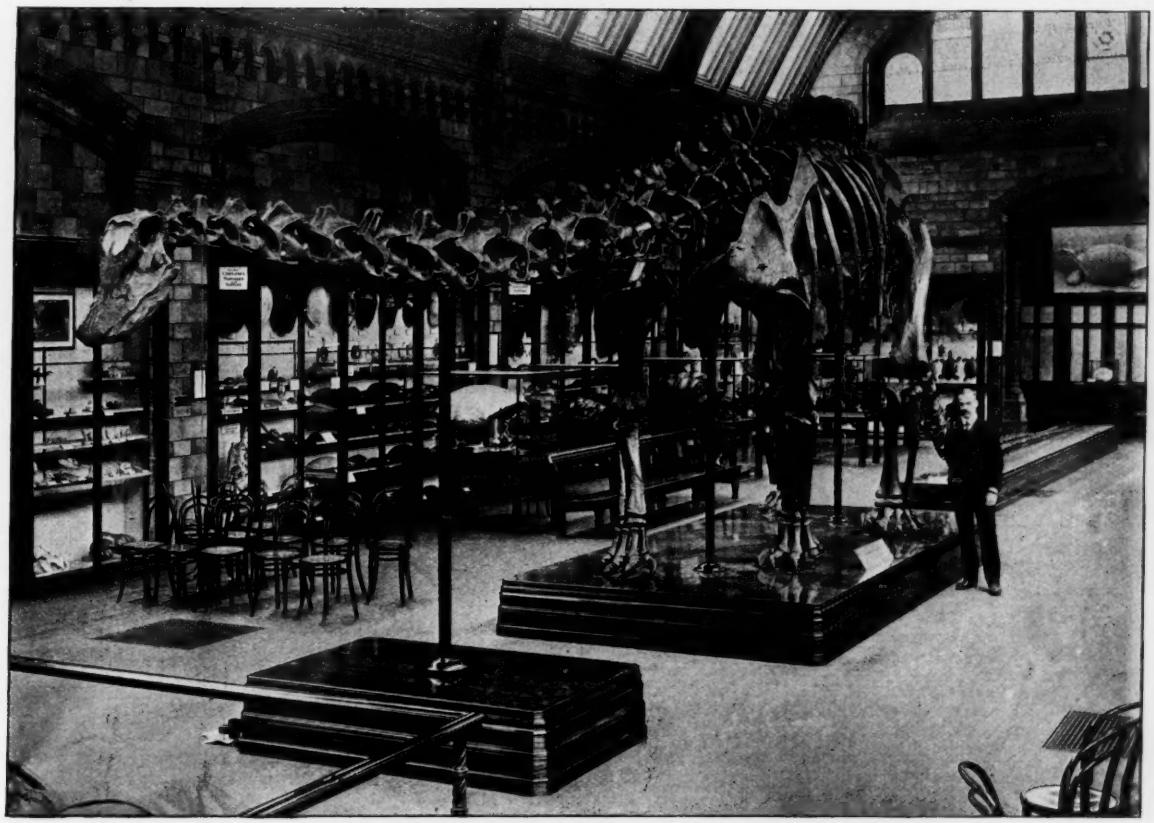
and were long and peg-like; as worn out they were replaced in constant succession. The manner of this replacement is indicated in Fig. 1, which shows a section through the upper jaw.

It has been suggested that this monster was largely aquatic in its habits, partly on account of its enormous bulk, and partly because of the position of the nostrils. These opened, not at the end of the snout, but in the form of a large hole between the eyes—the white shield in the front of the skull in the photograph. There can be little room for doubt, indeed, but that the peculiar position of these apertures represents an adaptation to an aquatic habitat. Probably Diplodocus, like the modern hippopotamus, passed most of its time submerged in rivers, and thrust the head out of the water at intervals, just far enough to enable breathing to take place. Here it lived upon succulent vegetation, which was torn up by the rake-like teeth.

The causes which led to the extinction of this monster, and of others of like kind, will always remain a mystery. These leviathans represent the high-water mark attained by the reptiles, and it is significant to note that they disappeared just as the mammals were entering the arena of life. The late Prof. Cope, indeed, suggested that these early mammals (Jurassic) played no small part in the overthrow of their giant neighbours; that beasts of the size of the shrew and hedgehog hunted out the nests of these colossal creatures and gnawing through the shells of the eggs, destroyed the young. This explanation savours rather of wild conjecture than scientific reasoning. It seems more probable that the Dinosaurs were viviparous.

A more plausible hypothesis as to the causes of extinction of Dinosaurs, and other animals which have attained huge proportions, is that of Dr. C. W. Andrews. "An almost necessary corollary," he remarks, "of this increase in bulk, is . . . the lengthening of the time taken to attain sexual maturity . . . . A necessary consequence of the longer individual life will be that in a given period fewer generations will succeed one another, and the rate of evolution of the stock will, therefore, be lowered in the same proportion. If, now, the conditions of life undergo change, the question whether a given group of animals will survive or become extinct, will depend upon whether it can undergo sufficiently rapid variation to enable it to avoid getting so far out of harmony with its surroundings that further existence becomes impossible. . . ."



Replica of Diplodocus. (*From the original in the Carnegie Museum at Pittsburg.*)

Finally, it may be well to remind our readers that the great American continent has by no means the monopoly of these titanic Dinosaurian beasts. In the British Museum, for example, there may be seen the limbs of an enormous Dinosaur known as *Cetiosaurius*, obtained some years ago in Oxford. This creature must have rivalled Diplodocus in size. The Great Iguanodon, again, which once roamed over our islands, might well have disputed the right of way with Diplodocus, inasmuch as it stood some 18 feet high, and had the fore limbs armed with powerful spurs. But of these, and others, we may have more to say on another occasion.

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Rare Living Animals in London.

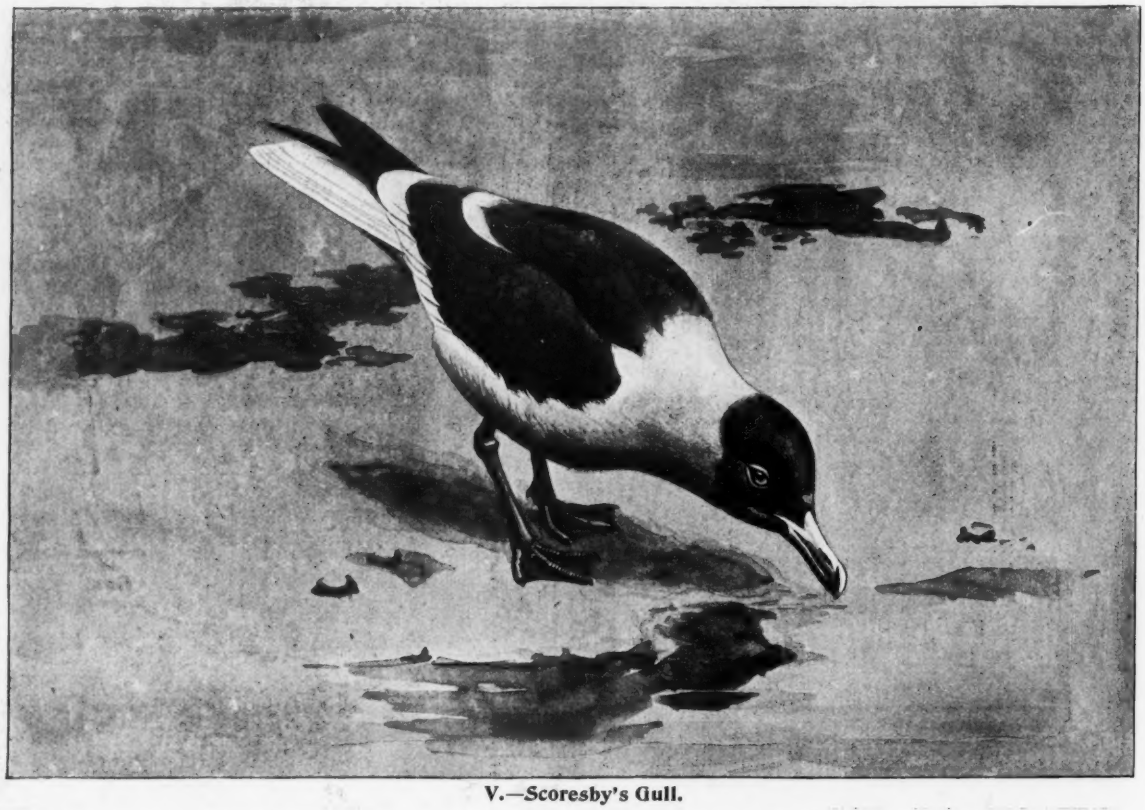
By P. L. SCLATER, DR.SC., F.R.S.

V.—Scoresby's Gull *(Leucophæus scoresbii).*

THIS well-marked species of gull was first described in 1823 by the late Dr. T. S. Trail in a paper read before the Wernerian Society of Natural History, and subsequently published in the fourth volume of that Society's "Proceedings." It was named by Trail after Scoresby, the "celebrated Navigator of Icy Seas," and the description was based on a specimen, then in the Museum of the Royal Institution at Liverpool, which had been brought home by one of the ships of that port engaged in the whale-fishery at the South Shetland Islands. Scoresby's gull is, in fact, exclusively an inhabitant of the Antarctic seas, and does not occur in the North Polar region, where the navigator after whom it is named made so many discoveries. Vigors had, no doubt, overlooked Trail's description, or he would not have renamed this bird in 1828, when it was called by him *Larus hæmatorlynctus* from its bright red bill, and was subsequently figured under the same name by Jardine and Selby in their "Illustrations of Ornithology." Vigors' specimens were procured by Capt. King at Port Famine in Patagonia, during the voyage of the *Beagle*, and nearly all the subsequent explorers of the coasts of the Magellan-Straits and Cape Horn appear to have met with this gull, which seems to be by no means uncommon in far southern latitudes.

This gull also inhabits the Falkland Islands, and, as recorded by Capt. Abbott, breeds there in December, "frequently laying its two eggs in the communities of the large Dominican Gull, *Larus dominicanus*, but it also has separate breeding-places." Eggs received from Capt. Abbott are in the collection of the British Museum.

More recent intelligence respecting Scoresby's Gull in the Falkland Islands has lately been procured by Mr. Rupert Vallentin, who informs us* that this bird, locally called "The Dolphin," is fairly common in the neighbourhood of Stanley, Port Louis, and Roy Cove, but that none were seen after the end of February. At Stanley and Port Arthur both adult and young specimens were always to be met with near the slaughter-houses in quest of offal in the months of November and December. At Roy Cove Mr. Vallentin frequently observed them walking on the floating beds of kelp and feeding on the crustaceans attracted thither by the decaying seaweeds.



V.—Scoresby's Gull.

By recent authorities Scoresby's Gull has been separated from the more typical forms under the generic title *Leucophæus*. Mr. Howard Saunders, our principal authority on this group of birds, points out that it has "a remarkably short, stout crimson bill, coarse feet with somewhat excised webs, and a decided hood in the immature stage, which wears off as the bird attains adult plumage." These characters were fully shown in the two specimens of this remarkable species which reached the Zoological Society's Gardens in October, 1903. One of these died in February, 1904, the other, which is still living, is the original of the accompanying drawing by Mr. Goodchild. So far as I know these are the only specimens of this bird that have ever been brought alive to Europe.

* "*Manchester Memoirs*," Vol. XLVIII. (1904), No. 23.

NOTES.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Tenth Satellite of Saturn.

ANOTHER interesting communication from the Harvard College Observatory announces the discovery by Professor W. H. Pickering of a new satellite to the planet Saturn, bringing the number of its attendants up to ten. The period of revolution of the new satellite is stated to be 21 days, which is very nearly equal to that of the seventh satellite Hyperion. The body is evidently extremely faint, as it is estimated to be three magnitudes fainter than Hyperion (which is about 17), so that it is doubtful if the new object will be detected visually for some time. The orbital motion is believed to be direct.

* * *

Seasonal Changes on Mars.

A telegraphic communication from Cambridge, U.S.A., announces that Mr. Percival Lowell, at the Flagstaff Observatory, Arizona, has again detected the evidence of seasonal changes on the Martian surface during the present opposition. The observational evidence consists chiefly of colour changes on the various well-known areas, and was first noticed by Lampland on April 4. The most prominent feature is seen in the Mare Erythræum, just above the Syrtis, which has again altered from blue-green to chocolate-brown. The Martian season at the time of observation, April 9, corresponded to the terrestrial February.

* * *

The Lens Mirror Telescope.

In an excellently-worded booklet, Mr. G. Whittle, of Liverpool, describes the construction of a new form of lens-mirror telescope that he has recently devised. In this the reflecting surface consists of the back of the lens, which is silvered and varnished, thus being completely protected from deterioration. Moreover, the length of the telescope body is greatly reduced. The lens adopted is a concave-convex for the main mirror, and a small meniscus is employed near the focus as a secondary mirror on the Gregorian plan for magnification. We have not had the opportunity of using the instrument, but its adaptability is stated to depend mainly on its absolute achromatism, and perfect *internal* reflection from a surface of pure silver deposited on a true surface of optical glass.

The Gregorian mounting has been chosen on account of the resulting image being in an erect position.

* * *

The New Solar Observatory on Mount Wilson in California.

Recent changes in the arrangement of the staff of the Yerkes Observatory, resulting in the transference of its former Director, Professor G. E. Hale, to the superintendence of the new solar observatory established by the Carnegie Institution on Mount Wilson, Pasadena, California, will probably mark an important epoch in the progress of scientific astronomical investigation.

It was only after very exhaustive preliminary tests that this station was selected by Professor Hale and his colleagues, and the numerous data supplied fully support their decision. Situated at an elevation of nearly 6000 feet, the station affords exceptional facilities for many solar investigations which cannot be efficiently carried out at places nearer sea-level. The plan of work outlined for the Institution includes:—

1. Frequent measurements of the heat radiation of the sun to determine whether there may be changes during the sun-spot cycle in the amount of heat received from the sun by the earth, and in the relative radiation of the various portions of the solar surface.
2. Studies of various solar phenomena, particularly through the use of powerful spectroscopes and spectroheliographs.
3. Photographic and spectroscopic investigations of the stars and nebulæ with a very powerful reflecting telescope, for the principal purpose of throwing light on the problem of stellar evolution.

From the records now in existence, it appears that solar observations will be possible on 300 days of the year, and the mean daily range of temperature only varies from 18·5° F. in April to 27·1° F. in November. The anemometer records indicate that the average wind movement is exceptionally low, indicating a uniform atmosphere. Operations were started with a 15-inch coelostat and a lens of 6 inches aperture and 61½ feet focal length, and many interesting observations made on the effect of heated air rising from the ground across the sight line of the instrument. By raising the piers as far as possible above the ground and taking special precautions for eliminating variations of temperature in the observing room, it has been found possible to obtain much better definition than usual.

Associated with Professor Hale in the new institution are Messrs. Ritchey, Ellerman, and Adams, all from the Yerkes Observatory. They hope to have the 5-foot Snow reflector available for use very shortly. Two concave mirrors of 24 inches (61 cm.) aperture, 60 feet (18·3 m.) and 145 feet (44·2 m.) focal length respectively are to be used for forming the primary images of the solar disc. The spectroscopic apparatus to be used in conjunction consists of:—

1. A spectroheliograph with portrait lenses of 8 inches (20·3 cm.) aperture and 60 inches (152 cm.) focal length, provided with four dense flint prisms. This will be floated in mercury, to reduce the friction on the rolling surfaces. Daily photographs of the entire solar disc with the calcium and hydrogen lines will be taken with this, using the image of 6·7 inches (17 cm.) diameter given by the concave mirror of 60 feet focal length.
2. A spectroheliograph of 5 inches (12·7 cm.) aperture and 30 feet (9·14 m.) focal length, provided with three light flint prisms of 50° angles. In this instrument the spectroheliograph will remain fixed, and the traverse of the image across the slit obtained by a slight rotation of the large mirror, and a corresponding motion of the photographic plate. The whole will be used for studying special zones of the solar image, and with a plane grating, for the study of sun spots, &c.
3. A Littrow spectroscope of 18 feet (5·49 m.) focal length, with large plane grating, to be used for study of solar rotation and spectrum of sun spots.
4. A large concave grating stellar spectrograph, of about 15 feet (4·57 m.) equivalent focal length, used with a collimating lens of 5 inches (12·7 cm.) aperture to eliminate astigmatism.
5. A prism spectrograph, with collimator of 1½ inches (3·8 cm.) aperture and 48 inches (114·5 cm.) focal length; dispersion train of one to four prisms, and various camera lenses. This will be used in the determination of wave lengths of stellar spectra, especially in the ultra violet regions.

The activity of Professor Hale and his staff is well shown by the recent publication of a beautiful reproduction from a photographic spectrum of the solar surface. This shows the violet region, including the H and K lines of calcium, which are about 4⅝ inches apart. This photograph was obtained at Mount Wilson with the Littrow spectrograph above mentioned, the grating being 4 inches in aperture with 14,438 lines to the inch, using the third order. An interesting feature of the photograph is the strength of the reversals over the regions occupied by faculæ on the sun's disc, and the scale is sufficient to show clearly that the continuous spectrum of the faculæ rapidly decreases in intensity as it approaches the centre of H_1 and K_1, where it almost disappears. This fact will prove most useful in future theoretical considerations.

XUM

Ephemeris for Observations of Comet 1904 II.

(12h., Berlin Mean Time.)

1905.	R.A.			Declination.			Relative Brightness.
	H.	M.	S.	°	′		
June 1	2	35	42	+ 64	50	8	0·16
3		39	27			51·6	
5		43	5			52·6	0·15
7		46	37			53·7	
9		50	3			55·1	0·15
11		53	23			56·7	
13		56	36	64		58·5	0·14
15	2	59	43	65		0·5	
17	3	2	44			2·8	0·14
19		5	39			5·3	
21		8	28			8·1	0·13
23		11	11			11·1	
25		13	48			14·3	0·13
27		16	19			17·8	
29		18	43			21 5	0·12
July 1		21	1			25·4	
3		23	13			29·5	0·12
5		25	18			33·9	
7		27	17			38·5	0·12
9		29	9			43·2	
11	3	30	53	+ 65	48	2	0·12

CHEMICAL.

By C. A. MITCHELL, B.A. (Oxon.), F.I.C.

New Experiments on the Making of Diamonds.

A BLOCK of meteoritic iron from Cañon Diablo was recently examined by Professor Moissan, and its composition suggested improvements in the artificial manufacture of diamonds. A section of the meteorite contained numerous diamonds, both black and transparent, together with amorphous carbon (graphite), and phosphorus and sulphur combined with iron. Experiments were therefore made to determine the influence of sulphur, silicon, and phosphorus upon the crystallisation of carbon under the artificial conditions of the laboratory. Iron was fused with a large excess of sugar in a crucible in an electric furnace, and as soon as the molten iron had become saturated with carbon (derived from the sugar) a small proportion of iron sulphide was introduced, and the crucible then rapidly cooled by immersion in cold water. It was found that the carbon had crystallised out in diamonds from the centre of the mass, and that the iron sulphide had considerably increased the yield of crystals. Rapid cooling of the fused mass, however, was essential, for otherwise no diamonds were formed. Silicon also promoted the crystallisation of the carbon, but phosphorus had no effect upon the results.

* * *

The Specific Serum Test as a Proof of Evolution.

Professor Haeckel in his latest work the "Evolution of Man," cites the recent results of physiological chemistry as additional proofs of the origin of man. Although a serum that has been rendered specific for one species of animal should give no precipitate with the sera of other animals (see KNOWLEDGE & SCIENTIFIC NEWS this vol. p. 86), the test breaks down in the case of animals of very closely allied species, and hence it is not surprising that a preparation that has been made specific for human serum should also react with the serum of an anthropoid ape and *vice versa*. It would thus be impossible to infer that a given stain consisted of human blood if there were a possibility of an anthropoid ape having been near the place. Another possible source of error in the serum test has been pointed out by MM. Linossier and Lemoine, who find that the differences are not so pronounced as has been asserted. They state that if solutions of too great a concentration be employed, the prepared sera are no longer absolutely specific, although the precipitates are much more marked with the serum of an animal of the particular species in question than with the sera of animals of other species. To obviate this error they recommend that the solutions employed should not contain more than one part in a thousand.

* * *

The Preparation of Pure Tantalum.

The rare metal tantalum occurs in various minerals, such as niobite, tantalite, and samarskite, and is usually found in association with another rare metal, niobium. Hatchett, in 1801, came to the conclusion that some of these minerals contained a new element, and different chemical compounds containing it were subsequently prepared. It is only quite recently, however, that Dr. W. von Bolton has succeeded in preparing the metal in a state of purity, and in his opinion the substance prepared by M. Moissan in his electric furnace was contaminated with carbon. Dr. Bolton's method of obtaining it consists in passing an electric current through a filament of brown tantalum oxide in a globe from which the air has been previously exhausted by means of a vacuum pump. This causes oxygen to be evolved from the incandescent filament, which gradually turns grey as it is reduced to the metallic state. Tantalum can also be prepared by fusing tantalum fluoride with potassium in a vacuum by means of an electric furnace. Metallic tantalum, which has an atomic weight of about 180, is extremely ductile. When the sheets are again heated and hammered they become extremely hard, and the metal may find a possible use as a substitute for the diamond in drills. Tantalum resists the action of acids, including *aqua regia*, and it can be heated to redness in the air without burning. It forms alloys with many other metals, but apparently does not amalgamate with mercury. When combined with about one per cent. of carbon it becomes very brittle. Messrs. Siemens and Halske have employed filaments of tantalum for electric incandescent lamps, and as a length of over 20 inches is necessary for a lamp of 22-candle power, they have constructed a special lamp for the purpose. The central support for the filament is of glass and has a number of radiating supports over which the wire is stretched. This lamp is stated to consume only half the electric energy required by the ordinary incandescent lamp, while a pound of the tantalum is sufficient for more than 20,000 lamps, so that a great saving is effected by its use.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

Gravels on South Norwood Hill.

WE have received a communication from Mr. J. K. Larkby in regard to the reputed eoliths found at the top of the hill by Mr. N. F. Robarts, F.G.S., two years ago, to which a reference was made last month. He has been unable to accept the flints as true eoliths, and it is to fair to say that others have questioned their authenticity. On the other hand they have been accepted as of human workmanship by many of the best local geologists, and they deserve mention in any work dealing with implementiferous gravels. We shall all agree with Mr. Larkby when he says: "Whilst fully accepting the artificial nature of eolithic forms, I recognise that the indiscriminate admission of evidence must serve to confirm the impression that the acceptor of eoliths is *ipso facto* a 'crank.'"

* * *

A Lost River.

The gravel which is found along the valley which leads from Caterham to Purley gives evidence of an important river which at one time flowed here. Early last year there was evidence of the stream in the rising again of what is known locally as the Bourne. This had not flowed since 1896, although previous flowings had generally occurred at shorter intervals. The rising of the feeders were to be seen at various spots in the valley, extending from the grounds of the "Rose and Crown" at Warlingham, where they were seen bubbling up at several places, notably on the site of the cocoa-nut pitch, to the gas-

works farther up. At Kenley, where building has been going on for some time, the gravel has been excavated and sifted. In a heap of gravel which I examined, in addition to a great number of sub-angular flints, there was a fair proportion of rounded stones and pebbles, of Oldhaven pebble-bed origin. Many of the flints had become encrusted with a covering of lime, after the manner of the action of so-called petrifying springs. Lumps of conglomerate were also found, and occasional pieces of red sandstone. The limestone encrustation of some of the flints clearly showed the present origin of the feeding springs from the chalk, whilst the presence of the sandstones takes one back to times when the river had a portion of its flow over the Lower Greensand farther south, and possibly over some of the sandstone beds of the Weald.

* * *

Pre-Glacial Valleys of the Northumberland and Durham Coalfield.

By a detailed examination of about 600 different borings in the area specified, Dr. D. Woolacott, F.G.S., has reconstructed with considerable pains some of the valleys which existed prior to the Ice Period, many of which have been completely hidden since by thick wrappings of boulder-clay. Although the subsequent existing drainage systems of boulder-clay areas are in most cases much the same as those on which they were superimposed, there are notable cases in which the subsequent drainage has been completely different to that previously obtaining. The greatest thickness of superficial deposits found was that at Newton Hall, in the Wash valley, when 233 feet of these lay above the old rock surface. A number of the borings show the rock-surface at a considerable depth below sea-level, such at Burdon Main, in the Tyne valley, where the rock was not reached except at a depth of 141 feet, this affording good evidence of considerable subsidence, as compared with pre-glacial times.

* * *

The Great Peak Fault.

In the course of a paper read before the Geological Society by Mr. R. H. Rustall, B.A., on the Blea-Wyke Beds and the "Dogger" in N.E. Yorkshire, the subject of the age of this well-known fault was touched upon. The author leaned to the view that it was partly of pre-Oolitic date. There is every reason to think, as suggested by Mr. Hudleston many years ago, that the fault was a distinct line of weakness, and that probably movement had taken place more than once in the history of the district. Disturbances in the earth's crust were apt to follow old lines.

* * *

Earthquake in England.

A reminder on a small scale of the earthquake convulsions which have taken place recently in India was experienced in the Midlands on the early morning of Easter Sunday. It is not improbable that the shock had a connection with the Indian catastrophe. The crust of the earth will for some time be occupied in settling down, so to speak, into greater permanency than it was left after the great underground earthslides which gave rise to the Lahore shocks. In fact, any one great quake may generally be regarded as the forerunner of other minor ones, and the shocks so caused may travel to regions where earthquakes are infrequent.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S. ,.B.O.U., &c.

Greenland Falcon in Co. Donegal.

IN the *Irish Naturalist* for May, Mr. Robert Patterson records the occurrence of a Greenland Falcon at Horn Head, Dunfanghy, on March 21. The bird was taken in a trap, and proved to be a female. The total length of this bird from the tip of the beak to the tip of the tail was 1 ft. 11 ins.; the expanse of the wing 4 ft. 3 ins. The weight is not recorded.

Corn Crake in Winter.

Though it is now generally believed that the Corn Crake not seldom remains throughout the winter in Ireland, authenticated instances of this stay are valuable. Mr. Robert Patterson records in the *Irish Naturalist* for May the fact that one of these birds was shot near Lurgan in January last. In England such cases are very rare.

* * *

Bittern in Co. Wexford.

One of these unfortunate birds was shot in November, 1904, at Curracloe, near Wexford. According to Mr. J. H. Johnson, who records this occurrence, a Mr. O'Neill heard the booming near his house. This statement requires some qualification, as the Bittern is generally believed to utter this note only during the breeding season.

* * *

Snowy Owl in the Shetlands.

One of these birds was killed in November last, according to the *Annals of Scottish Natural History* for April (which reached us too late for comment last month) at Ballinata. No particulars are given as to sex or measurements. News has just come to hand of another Snowy Owl killed in Norfolk during April last. Further particulars thereof we hope to give next month.

* * *

Albino Redshank in the Outer Hebrides.

A so-called albino Redshank was killed in October last in the Outer Hebrides, according to the *Annals of Scottish Natural History* for April. This bird, however, should rather have been described as isabelline and white, inasmuch as buff and cinnamon appeared conspicuously in the plumage intermixed with white. In true albinos, *all* pigment is wanting; hence the pink iris, which is hall-mark of the albino.

* * *

Arrival of Summer Birds.

From *The Field* for April 22 we gather the following list:—

Garden Warbler	St. Neots	... ...	April 13
Nightingale	"	... ...	" 15
"	Eastbourne	... ...	" 12
"	Tonbridge	... ...	" 15
"	Shoreham	... ...	" 15
"	Shere	... ...	" 16
"	Hockley	... ...	" 16
Landrail	Barnstaple	... ...	" 12

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

ALL who had the privilege of listening to Professor Nichols (of Columbia University, New York) at the Royal Institution, on the 12th May, were delighted with the apparent ease with which a difficult experiment was shown. The subject of the lecture was "The Pressure due to Radiation." It had been predicted by Maxwell that if his electro-magnetic theory were true, light falling on a body should repel it, and he calculated the force of the repulsion which would correspond to a particular amount of light; but this was exceedingly small. Crookes at first thought he had obtained experimental evidence of this pressure when he discovered that light vanes, mounted in a partial vacuum so as to be capable of easy rotation, were set in motion when one side of each face was blackened and light fell on the blackened face. This action, however, was afterwards traced to the effect of heat and not to light, and depends upon the presence of residual air in the exhausted vessel.

This air effect, when at a maximum, is thousands of times as great as the effect which would exist if no air were present; and it is its presence which creates the chief difficulty in measuring the pressure due to radiation itself.

XUM

The apparatus employed by Professors Nichols and Hull consists of two light mirrors mounted on a horizontal capillary glass tube which is suspended at its middle by a quartz fibre about an inch long. When a strong light (from the sun or electric arc) is focussed on one of the mirrors, it drives it back and thereby twists the fibre. The angle through which the suspended mirrors turn can be observed by reflecting a second beam of light from another mirror mounted on the axis of rotation.

The chief beauty of the experiment consisted in showing that for a particular pressure of the air the disturbance arising from it is almost zero; and most of their measurements were therefore made at this pressure. But even at other pressures *the first motion of the suspended vanes is always due to the radiation*. The reason of this is that the pressure due to the radiation acts instantaneously; but the air effect depends upon the vanes gradually warming up, so that the action arising therefrom is always delayed.

The results of Nichols' and Hull's experiments are in satisfactory agreement with Maxwell's theory.

ZOOLOGICAL.

By R. LYDEKKER.

The Pelagic Lancelet.

THE border-land between vertebrates and invertebrates naturally possesses an interest surpassing that which attaches to what we call ordinary members of the animal kingdom; that is to say, to those which conform more or less completely to a normal type and possess a host of near relations. One of the most remarkable of these inhabitants of the border-land is the tiny translucent creature of little more than an inch in length not uncommon on sandy shores in the Mediterranean, to which our great ichthyologist gave the appropriate designation of lancelet. Long considered a fish, it is now regarded as more nearly related to the sea-squirts, or ascidians; and with the latter is ranked as chordate rather than a vertebrate animal. Among its many peculiarities is the absence of any distinct head, the position of the mouth on the under surface of the anterior end of the body, and the ring of tentacles with which the opening of the mouth is surrounded. Many kinds of lancelets are now known, all save one of which conform more or less closely to the general type. The exception is a species long represented only by a single specimen taken during the scientific cruise of H.M.S. *Challenger* in the open sea. Of this species a number of specimens have recently been described, and these serve to show that it is a very distinct type indeed, characterised not only by its pelagic habitat, but by the position of the mouth on one side of the body, the absence of the ring of tentacles fringing the mouth-opening, and several other equally important structural peculiarities.

* * *

Luminous Shrimps.

The Prince of Monaco, whose active interest in the fauna of the deep sea is well known, is reported to have lately discovered luminous shrimps, which live at a great depth where all, of course, is dark. When placed in aquariums these crustaceans soon, however, loose their luminous properties. Probably most, if not all, abyssal organisms are luminiferous, or phosphorescent, some giving forth light from the general surface of the body, and others from special organs.

* * *

The Carnegie Dinosaur.

On May 12th, Lord Avebury, on behalf of the Trustees, formally received from Mr. Carnegie the gift of a model of the skeleton of the great dinosaurian reptile *Diplodocus carnegii*, which has been recently set up in the reptile gallery of the Natural History Museum under the immediate superintendence of Dr. Holland, Director of the Carnegie Museum at Pittsburg. The skeleton, as now set up, gives a far better idea of the enormous proportions attained by these gigantic reptiles than was ever previously possible in this country, even with the aid of the imperfect skeleton in the Geological Department of the Museum collected by Mr. A. N. Leeds, near Peterborough. The skeletons from which the model in the Museum were constructed were obtained from the Upper Jurassic formation of Colorado and Wyoming; from which horizon the late Prof. Marsh long since secured the remains of the typical species to which he gave the name *Diplodocus longus*. As set up, the skeleton measures about 75 feet in length, but were the skull and vertebræ arranged in a straight line the length would be some ten feet more. At the shoulder the creature stands about 14 feet in height. The skeleton is mounted with the head and neck stretched out nearly in the line of the back; but we may be permitted to doubt whether this was the normal attitude of the reptile in life, especially in view of the fact that the nostrils opened on the top of the head, which suggests an amphibious existence. *Diplodocus* differs from its relatives by its feeble teeth, which resemble lead-pencils, and are confined to the front of the jaws. Such a feeble dentition suggests that the creature procured its food in the water. By his munificent gift Mr. Carnegie has laid all in this country who are interested in natural history under a deep obligation.

* * *

Fossil Marmot Burrows.

Some years ago American geologists described certain large spirals of hard stone met with in rocks of soft structure under the name of "devil's corkscrews," or, more scientifically, as *Dæmonohelix*. How these strange and gigantic spirals were formed had long been a mystery, although some naturalists suggested that they were of vegetable origin. Dr. Holland has explained that they are really the solidified burrows of a marmot allied to the existing "prairie-dog" (*Cynomys ludovicianus*). Hence, we presume, *Dæmonohelix* becomes the generic name of a mammal.

* * *

The Man-like Apes.

Naturalists will probably be divided in opinion as to the value of Mr. Rothschild's paper on anthropoid apes in the April number of the Zoological Society's *Proceedings*, and some of them, at any rate, will not endorse all his views with regard to the nomenclature. One of the most interesting observations records the fact that two different types of orang-utans are to be met in the same districts, in one of which the faces of the old males are expanded into a kind of warming-pan shape, while in the other they are of more normal contour. Mr. Rothschild explains this by "dimorphism," and regards both types as belonging to a single species, and even to the same race. Among chimpanzis two distinct types are likewise stated to inhabit the same districts, but here the author regards the two forms as separate species, each of which may have several local races. Whether this explanation of a very curious puzzle will be generally accepted remains to be seen.

* * *

Papers Read.

At the meeting of the Zoological Society on April 18th Dr. A. Smith Woodward read a paper on the skeleton of *Cetiosaurus* (or, as being derived, *κήτη*, *Ceteosaurus*) *oxoniensis* from the Oxford clay of Peterborough; while the Secretary described a young Nigerian giraffe (*Giraffa camelopardalis peralta*). As mentioned in our last issue, Mr. A. E. Shipley described various internal parasites obtained in the Society's Gardens and elsewhere, and Mr. R. H. Burns discussed the anatomy of the leathery turtle. Messrs. Thomas and Schwann gave an account of a collection of South African quadrupeds, Mr. G. A. Boulenger described a new Yunnan newt, Dr. E. Lönnberg noticed hybrid European hares, and Mr. A. L. Butler referred to the giant eland of the Bahr-el-Ghazal. The papers read on May 2nd included one, by Prof. Minchin, on sponges of the group *Leucoselenia*, &c., a second, by Mr. Beddard, on the anatomy of the ferret-badger, and a third, by Mr. W. P. Pycraft, on the osteology and affinities of the birds of the family *Eurylæmidæ*.

XUM

REVIEWS OF BOOKS.

The Principles of Heredity. G. Archdall Reid, M.B., F.R.S.E. (Chapman and Hall, 1905.) This volume is, we are told, addressed to medical men, the evidence relied upon being largely drawn from medical sources. Nevertheless the author has so consistently avoided the use of technical language, and his reasoning is so clear and acute, that it should prove very interesting to the general reader.

The author commences with a chapter upon the "Theories of Heredity," following on with chapters upon "Theories of Evolution, Use and Disuse, and Spontaneous Variation." In these chapters he reviews the main features of the evolutionary theory, as accepted by the majority of biologists of the present day. The Bathmic theory and the Lamarchian theories are dismissed as fundamentally opposed to observed facts, there being little or no evidence to justify belief in the inheritance of acquired characters, even in the lower forms of life. The theory that organisms are gradually adjusted to their environment by processes of variation and selection is accepted.

The effects of use and disuse are dealt with in a lucid and most suggestive manner. Man and the higher animals are described as large superstructures of "acquirements" built upon comparatively slender foundations of inborn characters. The hair, the teeth, the nose, the nails, &c., are wholly inborn characters, and are quite unaffected by use and disuse, but the muscles of the legs and other limbs, the heart, the blood vessels, the lungs, &c., can only reach their proper development by acquirement, and can only be maintained by the exercise necessary for their acquirement. It is thus clear that the modifications resulting from use and disuse are not transmitted to subsequent generations, but only the power of acquiring modifications under similar circumstances.

Under the title of "Recapitulation" the author endeavours to establish and remodel the old theory that the development of the individual is a blurred recapitulation of the history of the race. This theory, as stated by Mr. Reid, like the many other theories of "Heredity," contains much truth, but not the whole truth. Each theory may form a stepping-stone to some final and completely satisfactory laws of heredity, but one feels that the pressing need of the moment is work. The laws governing the inorganic world were established by a host of workers experimenting until a mass of organised knowledge was accumulated which placed those laws beyond dispute. Each new work upon this subject impresses one that students of heredity rely too much upon empirical observation, and upon the work of the practical man in rearing animals and plants. Such sources of knowledge are too incomplete and disconnected to enable us to attain a complete knowledge of this important subject.

Under the title of "Biparental Reproduction" we are told that its tendency is to result in regression to the specific mean, and that there is not an iota of evidence to prove that biparental reproduction is connected with variation as a cause and effect. The author appears to disregard the fact that in the words of E. Ray Lancaster*: "Breeders of horses, cattle, and sheep, and dog, pigeon and poultry fanciers, crop growers, nurserymen, tulip maniacs, and the like . . . . . cross-breed here, and crossbreed there, until the specific potential is broken down and strange and unlooked for variations are born and grown up irrespective of strange and abnormal surroundings. From these congenital variations they select the desired forms, and perpetuate them with perfect assurance and security." A good example of what can be accomplished in this manner by biparental reproduction is the result of some hundred years' work upon the rose. From a comparatively few wild forms, many thousands of cultivated species and varieties have been produced. Chapters upon "Regression" and the causes of "Spontaneous Variation" conclude this section of the work, and chapters upon the "Evolution against Disease," "Narcotics," "Automatic and Voluntary Action," "the Mind of Man," Methods of Religious and Scholastic Teaching," and other subjects treated from an evolutionary point of view, occupy the remainder of the volume.

In a work of this character, extending over a wide field of knowledge, one naturally finds statements which invite criticism. Mr. Reid may, however, be congratulated upon having contributed a work to the literature of evolution in which he has approached the subject from a new point of view, and which contains much that deserves careful attention.

* *Nature*, November 29, 1894.

The Tutorial Chemistry.—Parts I. and II., by G. H. Bailey, D.Sc., &c. Second edition (University Tutorial Press), 3s. 6d. each part. This work, first issued some ten years ago, has already earned a good reputation, but modern progress, with its reforms in the methods of chemical teaching, has demanded that it should be brought up to date. The main features of the work have been retained, but Part I. (non-metals) now contains two distinct sections. Of these, section I. consists of an introductory course based on a series of simple experiments and designed to illustrate the leading laws and principles of the science and to train the student as early as possible in "scientific method." Section II. contains a systematic treatment of the non-metals illustrated by numerous instructive and typical experiments; the proofs of composition and constitution form a special feature, and in the case of each important substance some account is given of its history and the purpose for which it is employed. Part II. (metals) also consists of two sections, section I. being an account of physical chemistry, which has been here brought completely up to date. Section II. is a full account of the metals; the chemistry of radium, electro-chemical methods for extraction of metals, the determination of atomic weights, and many other matters of interest depending upon recent researches and discoveries have received special attention. The book, as it now stands, gives a complete account of chemistry as usually studied for University final degree examinations. For intermediate science students of London University who wish to keep closely to its syllabus, asterisks have been placed to those paragraphs which do not fall strictly within the scope of the examination. There are one or two instances in which one might have expected the book to be rather more up-to-date. For instance, very little is said about calcium or the new method of obtaining it. The new alloy "Invar" is not referred to by name, nor can we find any allusion to the recently discovered magnetic alloy of copper and manganese.

Modern Industrial Progress, by Charles H. Cochrane (Lippincott Co.), price 10s. 6d., is really a very fascinating book. It is not by any means a scientifically accurate account of this exhaustive subject, but the story is well told, the illustrations profuse and alluring (if not always very correct), and the matter abundant and of great variety. We are told of electric generators and X-rays, of electric trains and "converters," of wireless telegraphy, of steel manufacture and the treatment of ores, of aërial navigation and kites. Evolutions in vehicles and roadways, in ships, and in tools of destruction are described, as are canals and tunnels, timber getting and working, mining, food, and water. Engineering enterprises of all sorts are gone into, and, in fact, to give even a list of the matters which are here attractively described would fill more space than we can devote to it. What is here told must be taken with—well, a milligramme—of salt, but this minute saline admixture does not detract from its forming a very readable and even instructive book.

N-Rays: A collection of Papers communicated to the Academy of Sciences, by R. Blondlot; translated by J. Garcin (Longmans, Green and Co.; price 3s. 6d. net).—Professor Blondlot has experienced in his efforts to make known the N-rays the truth of the maxim that the way of the scientific discoverer is hard; and though other theorists before him have had to battle quite as hard for their theories, it is doubtful whether the scepticism expressed about the reality of the phenomena he has observed has ever been quite of the same kind. One might say that the sceptics, except in France, still outnumbered the disciples, and that the proselytes were few in number. But in a case of this kind one piece of affirmative testimony must outweigh a great deal of negative evidence, and M. Blondlot's critics are divided among themselves, some maintaining that the alterations which the hypothetical N-rays produce in the luminosity of a testing screen are due to heat, while others say that the alterations do not exist at all. In the domain of affirmative testimony there has lately been added evidence of the greatest importance from Professor Hackett, of Dublin University, who has attained such definite results that he is able to discern, through the aid of

his detector screen, the emission of N-rays from a silent tuning fork; and from Professor Broca, who has examined and distinguished the so-called physiological causes of the rays. We may perhaps sum up the case for the real existence of the rays by a method of questions and answers. Is the change (in the detector screen) due to physical causes proceeding to the screen? If so, then the physical existence of the N-rays, or of something analogous to them, is established. Is the phenomenon due to changes produced within the eye itself? If so, then physiology must explain all the correlated and complicated phenomena which result—in terms of optical illusion such as the structure of the eye could produce. Lastly, is the phenomenon due to the mind of the observer? Then, if so, psychology has a task similar to that we have suggested for physiology. If on the contrary all these hypotheses are false, and there is *no* appearance of change in the detector screen; that is to say, if, in other words, M. Blondlot, Professor Charpentier, Professor Hackett, M. Broca, and M. d'Arsonval are united to bear false witness, the whole matter seems one for the alienist, for such a tissue of related and corroborative falsehood was never before recorded. We do not hesitate to say, therefore, that we believe the establishment of the objective reality of the N-rays to be merely a matter of time and careful experiment. This end will be furthered by the translation before us of the extremely straightforward, clear, and workmanlike papers which M. Blondlot has communicated to the Paris Académie des Sciences. Here we have collected his own observations, the gradual process of development of his experiments, and his candid efforts to meet and reply to criticism. No one can pretend to pass judgment without carefully reading this collected series of papers, to which additional value is given by M. Blondlots' directions for preparing the detector screens. A screen of the kind is furnished as a frontispiece to the work; and we cannot do better in taking leave of it than to quote M. Blondlot's warning as to the method of observation of N-rays: "It is *indispensable* in these experiments to avoid all strain on the eye, all effort, whether visual or for eye accommodation, and in no way to try to fix the eye upon the luminous source whose variations in glow one wishes to ascertain. . . In fact, the observer should accustom himself to look at the screen just as a painter would look at a landscape. To attain this requires some practice, and is not an easy task. Some people, in fact, never succeed."

On False Education, by Frederick Hovenden, F.L.S., F.C.S., F.R.M.S. (Watts; price 3d).—It is perhaps invigorating and salutary occasionally to read attempts to upset and prove illusory one's deeply-imbibed dogmas, or at all events to hear them investigated, dissected, and criticised. We have been brought up to believe in mathematics as a subject deserving of our highest respect; infallible, conclusive, beyond argument. Yet here we are suddenly confronted with an assertion that the whole thing is a mockery and a delusion! Arithmetic exists; two and two still make four. Multiplication is but addition repeated; two and two and two, that is, two added three times over, make six. But according to this author, 2×3 is not at all the same as 3×2. Algebra is delusive; $2a \times 3b$ is nonsense; as well say multiply two apples by three pears! All this starts one thinking. Where are we?

What Do We Know Concerning Electricity? by A. Zimmern, B.Sc. Pp. 140. (Methuen and Co., London; 1s. 6d. net).—This is a delightful elementary account of electrical phenomena intended for readers who may wish to obtain some knowledge of the subject, and who "yet may not have the desire or opportunity to make a thorough study of the subject." The aim of the author will certainly be fulfilled. Simple though the language is, it seems to be wonderfully accurate; and throughout a style which approaches distinction is maintained. The following extracts—which refer to different questions—will illustrate the author's cautious attitude: "The pictorial representation [of the processes of electrolysis] which scientists now adopt as a 'working hypothesis' is this!" "The modern conception of an ether is an invention due to Huyghens. I use the word invention advisedly because we have no experimental evidence for its existence. . . . Yet . . . there is a great and increasing amount of circumstantial evidence for the existence of *something* of which the ether as we conceive it is the expression suited to our present knowledge." This is excellent. We leave the book with regret that we have not referred to the chapters on the passage of electricity through gases and on radio-activity.

Bacteriology.—A Laboratory Guide in Elementary Bacteriology, by William Dodge Frost, Ph.D. Third edition (Macmillan; price, 7s. net).—If one wished to review Dr. Frost's guide to the bacteriological student in the shortest possible number of words, one would say that it was exactly what it professes to be in its title. It details for the student the exact methods that he will have to follow in the bacteriological laboratory in order to obtain a thorough working knowledge of the science, and to fit him for more extended research. It is arranged with two ideas in view; the first, and perhaps the more important, to indicate the experiments which a student will have to make and the best way of making them—and in this respect the third edition differs from those which have preceded it by substituting new and improved methods of established examinations of bacterial cultures; and, the second, the best order in which to take these experiments. Thus we proceed from the making of bouillon for cultures to the inoculation of animals and the bacteriological examination for human autopsies. The second subdivisional arrangement of Dr. Frost's volume is that which suggests the study of the various bacteria in groups, the most logical and reasonable method, and the one which is most in keeping with recent tendencies. It is a most valuable and practical manual.

Sociology.—Sociological Papers, by Francis Galton, E. Westermarck, P. Geddes, E. Durkheim, Harold Mann, V. V. Branford, and James Bryce. (Published for the Sociological Society: Macmillan).—The contents of this volume consist principally of the papers read before the Sociological Society last year, and amid a mass of interesting material, the essay by which Dr. Francis Galton strove to establish the new science of "Eugenics" is, perhaps, the most important. Dr. Galton's idea is that we may establish the coming race, sound in wind and limb, in mind, and in morals, by selective breeding. It is a hypothesis which we believe to be vitiated by the fact that we do not know what to breed for; that it is not the fittest that survives, but the more fit; and short of exterminating the unfit at birth, a proceeding to which mankind still entertains a sentimental objection, we do not think any method of artificially improving the births of the world would effect much. More entertaining, however, is Dr. Galton's effort to remedy a noticeable omission in the annals of talent. We have many biographies of great persons, but no collection of biographies of gifted families; and since it is probable that brain is as much a heritage as bone or muscle, it is as well for those who wish to improve the race to know how far and in what directions the cleverness of a parent is transmitted or inherited. Dr. Galton's way was to send a letter to Fellows of the Royal Society asking them to give particulars of the noteworthy achievements of their near relatives; and from the 250 replies received, he arrived at the general conclusion that ability as measured by achievement tended to be a family characteristic in a marked degree. Achievement as a rule was measured by mention in the "Dictionary of National Biography," in the "Encyclopædia Britannica," and in a lesser degree in "Who's Who?" but besides families distinguished in this way, there were others whose members were reputed to have a high level of ability. We each of us have on an average ten near male relatives who live long enough to attain distinction if they have it in them—two grandfathers, one father, two uncles, one brother, and four first cousins. Usually distinction is sufficiently rare to make it probable that if one of these ten reaches Dr. Galton's standards of distinction, there is genius in the family; but Dr. Galton's statistics show that where Fellows of the Royal Society are concerned there is the average of no fewer than four distinguished persons in the ten. Some of the family trees are so remarkable as to be worthy of special notice—that of the Darwins, for instance. Charles Darwin was the grandson of Erasmus Darwin, F.R.S., physician, poet, and philosopher; and of Josiah Wedgwood, F.R.S. He was the son of Robert Darwin, F.R.S., a distinguished physician; and was the nephew of Charles Darwin, who had a career of extraordinary promise. He was, of course, related to other descendants of Josiah Wedgwood, and to the Galton family among them. Of his four sons, Francis, George, and Horace are all Fellows of the Royal Society, and Leonard Darwin is a brilliant scientific Engineer officer. Similarly, the Horsleys are related to the Hadens, the Brunels, and the Bramwells.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The selection of a printing process.—In scientific work one is often satisfied with the production of the negative, and sometimes rightly so, but for demonstration, reproduction with letterpress, storing for convenient reference, and in other cases, it may be desirable, if not necessary, to make prints. In one sense a print must always be inferior to the negative because it is a stage further from the original, but it may be practically far superior because it gives the photographer further opportunity for making more conspicuous the very matter that he wishes to investigate or demonstrate. In the choice of a printing process there are more possibilities than are generally recognised.

There are now to be obtained silver printing-out papers specially prepared for giving vigorous prints from poor and flat negatives, and by the use of them important detail in a photo-micrograph or a spectrum photograph that is feebly represented in the negative may be made much more conspicuous. Among development papers, slow bromide or "gas-light" papers are specially suitable for this purpose. A smooth surface should always be selected, and if it is made more shiny still by drying it on a sheet of ebonite (or glass or ferrotype iron), the detail will show still more markedly. It may be that in a print so obtained much of the other parts of the subject will be lost in obscurity, but then it is easy to prepare another print on an ordinary paper, making the best of the subject as a whole, and to show this with the special print of the particular part that needs emphasis.

If it is desired to show the general characters of a subject without special emphasis of detail, as may be the case with photographs of some geological subjects, a rougher surfaced print is an advantage. A matt-surfaced bromide print, or a print on a paper that has no layer of medium on it (gelatine or albumen), such as platinotype paper and some silver papers, will serve this purpose. Here the detail will not be lost, but it will be less obtrusive.

If permanency is the chief desideratum, there are three processes that specially come to mind, namely, platinum and carbon printing, and the production of enamels. Of these, undoubtedly the most convenient for those who do not make a business of photography is printing in platinum, and, although it is making rather a fine distinction to compare the probable lasting properties of these three kinds of photographs, I think that a platinum print would probably out-live the others. If it were my duty to prepare photographic records for the express purpose of being in usable condition a thousand years hence, I should be inclined to prepare prints by these three processes, unless the subject was too large for making an enamelled plate from it, and then I should not much regret having to rely on the other two. But if I omitted to prepare platinum prints, I should feel that I had not been faithful to my trust. If a platinum print is not brilliant enough to clearly show the detail to which attention is to be directed, it may be waxed, a process that used to be in vogue years ago in connection with silver prints, but is rarely used now. For this purpose white wax is melted with turpentine in such proportion that the mixture, when cold, is of the consistency of a thin pomatum. This is applied to the surface of the mounted print by means of a small flannel pad with a light polishing movement similar to that adopted when "French polishing" wood-work.

Gelatine v. Collodion, etc.—It has sometimes been deplored, for the sake of experimental rather than practical photography, that collodion has given place to gelatine as the vehicle of the sensitive salt. Gelatine is supposed to be complex, variable, and uncertain, and no doubt it justifies its reputation, but whether the collodion film is either more simple, stable, and reliable is open to considerable doubt. Those who have stored both gelatine and soluble guncotton will know that the former appears to remain unchanged indefinitely, while the latter cannot be preserved in a glass bottle for very long, because of the continual evolution of acid vapours that must be allowed to escape, and that if stored as is usual in paper lined tin canisters or cardboard boxes, the paper gets rotten and the tin corroded. It is too often taken for granted that guncotton is merely cellulose nitrate, and that the sulphuric acid used with the nitric acid in its preparation merely facilitates the action of the nitric acid on the cotton, perhaps chiefly by its dehydrating action. But it has long been known that sulphuric acid has a specific action of its own upon cotton, and Messrs. Napier Hake and R. J. Lewis have recently shown (*Jnl. Soc. Chem. Ind.*, 29th April, 1905) that cellulose sulphates are generally, and probably always, formed in small quantities in the preparation of guncotton, and that they often, if they do not always, remain in the finished product, and are an element of instability. This investigation refers to the guncotton of warfare, and photographers who refer to the paper should bear in mind that soluble guncotton or pyroxyline is prepared with far less care than the other.

Experimentalists who want a pure sensitive film free from the uncertainties of either gelatine or collodion have sometimes regarded the daguerreotype process as very advantageous. But even here there are uncertainties, for General Waterhouse has shown that an ordinary clean silver surface is sensitive to light, while if thoroughly cleaned by heating and treatment with acid it becomes insensitive. These is little doubt that whatever support or medium is used for the sensitive salt, its character must be taken into account in investigational work, and that none of those hitherto shown to be available can be regarded as inert. But this is no justification of the extreme view that has sometimes been expressed to the effect that the sensitive substance in ordinary plates is not silver bromide, but a product of the action or combination that has taken place between it and the gelatine.

Radiation or Emanation.—The fact that many substances give off something, whether a radiation or a gaseous emanation, that produces the developable condition in gelatino-bromide plates is being gradually extended. The latest additions to the list of "active" substances are mercuric cyanide, mercuric chloride, a few other mercury salts, and a compound of mercuric cyanide with phenylhydrazine. Metallic mercury was found to be quite inactive, as Dr. Russell stated it to be some years ago. Messrs. R. de J. F. Struthers and J. E. Marsh have obtained these results, and further details concerning them will be found in their paper published in the *Journal of the Chemical Society* for April (p. 377).

We regret that the word actinism in two places in the May issue appeared spelt activism—contrary to author's copy.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Photo-Micrography with Ultra-Violet Light.

THE resolution of a microscope objective is determined by its aperture, and though the use of immersion objectives has enabled us to increase the latter, and, consequently, the former also, to an extent undreamt of in the days when we were limited to the use of lenses used dry, a suitable all round medium has not yet been discovered which will satisfactorily replace cedar oil and so enable objectives to be made of still greater aperture. True, an immersion lens has been made which is used with mono-bromide of naphthalene, and which has a proportionately greater aperture even than those used with cedar oil, and, therefore, greater powers of resolution, but this medium is, unfortunately, not a suitable mounting medium for most objects, so that the lens is but little used. Without entering into the diffraction theory, it may be stated that with an objective of given aperture—say 1.4 N.A., which is approximately our present practical limit—we can only increase the resolution by reducing the *velocity* of the light by which we illuminate the object—that is, by increasing the refractive index of the medium in which the object is mounted—for example, when it is mounted in realgar, or by using light of *shorter wave-length*. The first method has, of course, its limits as already mentioned, but there remains the second. Now, it is well known that white light is made up of rays of different refrangibility, and, accordingly, of different wave-lengths, of which those at the red end of the spectrum are the longest, and those at the violet end the shortest. Therefore, mono-chromatic light, selected by means of a prism or screen, and taken from the blue, or, still better, the violet end of the spectrum, will give us greater resolution than ordinary white light which combines so many rays of longer wave-lengths. This fact is taken advantage of in photography, and the result is a very definite increase in resolution, say, of the markings of a difficult diatom. When violet light is used the eye is, unfortunately, little sensitive to these rays, so that it is not easy to see the object, and though such light has high actinic value, it is difficult to focus the object satisfactorily when it is used. Dr. Kohler, of Jena, has, therefore, experimented with ultra-violet rays, which are invisible, but can be used for photography, and their still shorter wave-length, 275 $\mu\mu$, has proportionately greater resolving powers. The lenses are made of crystal and fused quartz, and as mono-chromatic light is to be used, they need correction only for spherical and not for chromatic aberration. The light is obtained from electricity passing between cadmium electrodes. But the human eye, as we know and have just stated, cannot see these rays, and so cannot focus and adjust them. Therefore, Dr. Kohler has devised what may be called an artificial eye; in other words, he constructs what corresponds to an eye-lens, made of crystal, and a retina made of fluorescent glass, which responds to these ultra-violet rays. The image on this "retina" is examined visually by means of a lens, in which case Dr. Kohler has found magnesium light, of wave-length 280 $\mu\mu$, better than the cadmium light. The fluorescent light, however, is, unfortunately, harmful to the eye, and, apart from this, the best results are given by photography. The objects, mostly organic tissues, have been so far mounted in dilute glycerine or in salt solution, and structure has been made evident, which, before, required staining to bring out, more especially because of the comparative impermeability of certain structures, such as the horny layer of the skin, and plant membranes. The lens and its adjuncts were made by the firm of Zeiss, and has recently been exhibited at the Natural Science Club in Cambridge. It may have considerable possibilities.

Royal Microscopical Society.

April 19, at 20, Hanover Square, Dr. Dukinfield H. Scott, F.R.S., President, in the chair. The Secretary read a description of an old portable microscope made by W. and S. Jones, which was said to have been the pocket microscope of Dr. Jenner. Mr. W. J. Dibdin exhibited a slide of *Bacillus typhosus*, and explained the method adopted in staining and mounting. He also exhibited photo-micrographs of the slide at magnifications of 2,500 and 5,000 diameters, with the flagella well displayed. Mr. A. E. Conrady gave a *résumé* of his paper, "On the Application of the Undulatory Theory to Optical Problems," illustrated by diagrams shown upon the screen. Dr. Spitta said that in using the method of graphical representation, Mr. Conrady rendered the subject intelligible to most people, and inquired if the method of explaining the subject originated with the author, as he did not remember having seen it in any of the text-books. Mr. Conrady said the method was not devised by himself, but would be found in the article on the Wave Theory, by Lord Rayleigh, in the "Encyclopædia Britannica."

Quekett Club Journal.

The half-yearly issue of this Journal contains rather less matter than usual. It appears from the Annual Report that owing to an increase of rental it was found necessary to economise in the Journal by shortening the reports of meetings—which is probably not much loss—and in omitting the reviews of books, which were a useful feature. However, I am glad to see that the membership has considerably increased during the past year, and that the finances of the Club are in a satisfactory condition. The Journal contains Dr. Spitta's address on "Improvements in Modern Objectives," a translation by Mr. Rheinberg of Prof. Ambronn's review of Prof. Abbe's work, and other papers and notes.

Watson-Conrady Photo-Micrographic Apparatus.

Mr. A. E. Conrady has computed for Messrs. W. Watson and Sons an entirely new system of lenses for photo-micrography, which I have found to give better results than any other apparatus which has come under my notice. It is mounted in the modern way on an optical bench, by means of which each part is capable of ready adjustment whilst keeping in exact alignment, centring screws being provided for the preliminary adjustments. Taking the parts in order we have first a source of illumination. This may be by arc light or by oxy-hydrogen jet, mechanical adjustments, both vertically and horizontally, being provided, and the whole enclosed

in a Russian iron case. The usual large condenser of two simple plano-convex lenses is replaced by an achromatic and aplanatic doublet about 2¼ ins. diameter, which projects a sharp, enlarged, aërial image of the source of light. The corrections of this condenser are of an unusually high order. Condensers of four inches or more have generally been considered essential, but a little consideration will show that no microscopical apparatus can utilize a cone of light of so large an angular extent, whilst the spherical aberration of all but the innermost zone of such uncorrected condensers is so considerable as to render the greater portion of these lenses quite useless for practical purposes. Thus the small but really aplanatic condenser yields a brighter illumination than could otherwise be utilized, because losses by absorption and reflection are reduced to a minimum, whilst those due to spherical aberration are entirely done away with. In fact, the clear diameter even of this condenser is too large for most microscopical purposes, and an iris diaphragm is therefore provided close to the lens so that its aperture may be reduced to any desired extent. The condenser is so adjusted as to project an aërial image of the source of illumination from 10 to 15 ins. away from the microscope stage—*i.e.*, at a suitable distance from the sub-stage condenser of the microscope. In the plane of this aërial image is provided a second iris diaphragm, by means of which the flame image can, if necessary, be reduced to such a size as will just cover the amount of object that is to be photographed. This second iris diaphragm also materially assists in diminishing internal reflections in the microscope tube. A thin auxiliary lens is provided as an accessory which, when placed close to the intermediate diaphragm, forms an image of the large condenser on the iris of the second condenser, thus collecting all the light passing through the latter, and filling even large sub-stage condensers with light. For low powers the large aplanatic condenser alone can be adjusted so as to project an image of the source of light on the diaphragm of the lens in use, thus evenly illuminating objects two inches or more in diameter. The usual cooling trough is provided. I have been using this apparatus for some time and have found that the necessary adjustments are very readily made by means of the iris diaphragms, and that once made they require but little subsequent alteration; in fact, it is only a matter of a few minutes to remove the microscope from the table where one is working and to place it in position for photography, with the knowledge that very simple adjustments will give perfect optical results. The condenser not only gives unusually perfect illumination, but very considerably reduces the necessary exposure. I do not, of course, mean to imply by this that successful photomicrography is merely a question of optical adjustment and exposure.

Notes and Queries.

J. E. Blomfield (*Sevenoaks*).—I am afraid you will not find anyone who lays himself out to supply the rarer fresh-water algæ. I have made inquiries here and cannot hear of any such person. An advertisement might be of use. Do you know Prof. G. S. West's "British Fresh-Water Algæ"?—it contains useful hints as to collecting.

John Hume (*Newcastle-on-Tyne*).—Soft sections want very careful dehydrating and clearing. The alcohols must be carefully proportioned, as 30 per cent., 50 per cent., 75 per cent., and 95 per cent., and the section should stay a good time in each bath. It would be best to clear in xylol and mount in xylol-balsam, and it would be advisable to have an intermediate bath of half xylol and half alcohol between the 95 per cent. alcohol and the xylol. Perhaps also your sections are too thick, in which case they do not get properly permeated with the media and shrinking at one stage or another is very likely to happen. Benzine and benzole are different names for the same substance. Sections preserved in alcohol cannot be stained with carmine or hæmatoxylin made up as watery stains—alcoholic solutions must be used. Probably your trouble is due to your overlooking this fact. Eau de Javelle is practically hypochlorite of potash, and in using it you are putting back into the section the water which the alcohol had removed, alcohol being essentially a dehydrating agent. Sections stained with a watery solution of hæmatoxylin should mount well in glycerine jelly if properly stained. After staining, they should be washed in tap water, not distilled water. This deepens and fixes the colour, owing to the calcium salts it contains.

N. L. Gillespie (*Fulham*).—Slides for sending abroad are best packed in the little wooden boxes which can be obtained from the opticians, fitted with upright racks. They are very cheap. Each slide should have its edges well packed into the rack with cotton wool. A good way, however, is to fold a strip of paper of suitable length into a strip one inch wide, so that it contains several thicknesses of paper, and then fold two such strips in and out between the ends of the slides, one strip at each end, in in such a way that a double tongue of the strip lies between the ends of each slide, projects inwards for about an inch (not reaching the mount), and so separates it from those immediately above and below. The nest of slides is then tied tightly round with string and carefully packed in any handy box. Care must, of course, be taken that the last slide of the nest has its mount turned inwards for protection like the others.

J. Cooper (*Wigan*).—The best pocket lenses are those made on the Steinheil principle. They are aplanatic—which means flat in the field right up to the margin of the lens—and achromatic, or free from colour. They are of brilliant definition and a great comfort to the eyes. Such lenses are known as aplanatic pocket lenses, and are made by all the leading microscope makers (see the advertisement columns of this Journal) and there is little to choose between them. They cost from 12s. to 15s. each, and the powers run 6, 10, 15, and 20, or thereabouts. I think 6 is the handiest size, and certainly it is the most comfortable to use; the higher powers are very tiring to the eyes. The lens should be mounted for the pocket.

J. Strachan (*Ballyclare*).—With reference to my recent article on the Fibrous Constituents of Paper I must confess that I have never found any quantitative method of estimating the percentages of various fibres to be trustworthy, except in a very rough and ready way. Your method of counting the various fibres is probably the best and is accurate within its limits, but is very laborious; and I am afraid I must ask you to forgive me if I am not able to check your results as my time is very fully taken up with work of many kinds. If you will be good enough to send on the samples of chemical wood pulp and mechanical wood pulp, which you kindly offer, I shall be glad to accept them on behalf of my readers, and to distribute them to any who care to apply, provided they will enclose a stamped addressed envelope for the purpose.

A. H. Glaister (*Darlington*).—Your method of marking the actual magnification on the negative of a photo-micrograph has been often used, but I am obliged to you for your communication; and as some of my readers may not know of it, I will give the method herewith as emanating from you. Briefly, it consists in first taking a photo-micrograph and then, without altering the adjustments of camera-length, tube-length, eyepiece or objective in any way, of replacing the dark-slide by ground-glass, and projecting thereon the lines of an ordinary stage micrometer. The distance between the lines is then marked on the edge of a slip of paper, and this is used as a template, by which the marks can be scratched across the negative at the side of the photograph. The value of the lines is added, and the whole reproduces on the positive as part of the photograph.

[*Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge*]

The Face of the Sky for June.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 3.52, and sets at 8.4; on the 30th he rises at 3.48, and sets at 8.18.

Summer commences on the 22nd, when the Sun enters the sign of Cancer at 3 a.m.; on this, the longest day, he rises at 3.45 and sets at 8.18.

The equation of time is only 6 seconds on the 14th and 15th, hence these are suitable dates for adjusting sundials by the clock, as correction for longitude need only be applied.

The solar cycle is approaching a maximum, and sunspots may be observed on any clear day, whilst spectroscopic observations of the Sun's limb have, of late, shown many fine prominences.

The position of the Sun's axis and equator, required for locating the spots, is as follows:—

Date.	Axis inclined from N. point.	Equator N. or S. of Centre of disc.
June 1 ..	15° 33′ W.	0° 28′ N.
,, 10 ..	11° 59′ W.	0° 37′ S.
,, 20 ..	7° 41′ W.	1° 49′ S.
,, 30 ..	3° 10′ W.	2° 57′ S.

THE MOON:—

Date.	Phases.	H. M.
June 3 ..	● New Moon	5 57 a.m.
,, 10 ..	☽ First Quarter	1 5 p.m.
,, 17 ..	○ Full Moon	5 52 a.m.
,, 24 ..	☾ Last Quarter	7 46 p.m.
June 14 ..	Perigee 227,500 miles.	1 0 a.m.
,, 25 ..	Apogee 251,200 ,,	11 48 p.m.

OCCULTATIONS.—The only occultations occurring before midnight are as follows:—

Date.	Star's Name.	Magnitude.	Disappearance.	Reappearance.
June 12 ..	1^1 Virginis	6·1	7.56 p.m.	8.41 p.m.
,, 12 ..	1^2 Virginis	4·9	8.22 p.m.	9.24 p.m.
,, 20 ..	29 Capricorni	5·5	(Star below horizon.)	10.52 p.m.

THE PLANETS.—Mercury is a morning star during the former part of the month, and is in superior conjunction with the Sun on the 24th. Throughout the month the planet is not well placed for observation.

Venus is a conspicuous object in the early morning sky, rising about 2 a.m. near the middle of the month. The planet is at greatest brilliancy on the 2nd.

Mars comes to the meridian at an altitude of 23° shortly before 9 p.m. on the 15th, and is situated near the double star α Librae; he is readily distinguished by his brightness and ruddy colour. The diameter of the planet is 16″; the disc as seen through the telescope appearing slightly gibbous with dark markings in the southern hemisphere. The northern hemisphere of the planet is inclined towards the earth, but the snow cap is scarcely discernible, as the season of this hemisphere on Mars corresponds to our early September. The planet is at the stationary point on the 18th, after which his motion is direct or easterly; on the evening of the 13th the Moon is 6° N. of the planet.

Jupiter is a morning star in Aries, rising at 2.0 a.m. on the 19th.

Saturn is a morning star in Aquarius, rising shortly before midnight near the middle of the month. The planet is stationary on the 14th.

Uranus is in opposition to the Sun on the 24th, hence about this date he is on the meridian near midnight, but, on account of his great southerly declination, he only attains a meridian altitude of 15°. The planet is situated about midway between the stars μ and λ Sagittarii, and although just perceptible to the naked eye, is readily found with slight optical aid.

Neptune is in conjunction with the Sun on the 30th, and consequently is unobservable.

METEOR SHOWERS:—

Date.	Radiant.		Name.	Characteristics.
	R.A.	Dec.		
	h. m.			
June—July	17 16	− 21°	α Scorpiids	Fireballs.
June 13	20 40	+ 61°	α Cepheics	Streaks, swift.

Double Stars.—α Librae, XIV.^{h} 46^m, S. 15° 39′, mags. 3, 6; separation 230″; very wide pair.

β Scorpii, XVI.^{h} 0^m, S. 19° 33′, mags. 2·7, 5·2; separation 13″·1.

M 80 (Scorpio). A compact globular cluster half way between α and β Scorpii; looks like a nebula in small telescopes.

The International Ornithological Congress.

THE fourth meeting of the International Ornithological Congress, under the Presidency of Dr. R. Bowdler Sharpe, will take place in June at the Imperial Institute, South Kensington. H.R.H. the Prince of Wales, K.G., has graciously accepted the post of Patron. The General Committee contains the names of many of the best-knowu ornithologists throughout the world who are likely to be able to attend the meeting.

The first meeting of the Congress will be held on Monday, June 12, at 9 p.m., when there will be an informal reception at the Imperial Institute. A General Meeting will take place next day at 10 a.m., and the five Sections (Systematic Ornithology, Migration, Biology, Economic Ornithology, and Aviculture) will assemble at 3 p.m. on that day. The Sections will meet again at 10 a.m. and 3 p.m. on Wednesday, June 14, and in the evening of that day there will be a conversazione at the Natural History Museum. Thursday, June 15, will be devoted to an excursion to the Zoological Museum at Tring, where the Members will be the guests of the Hon. Walter Rothschild, M.P. On Friday, June 19, there will be a General Meeting of the Congress at 10 a.m. In the afternoon the Lord Mayor of London will receive the ornithologists at the Mansion House, and in the evening the British Ornithologists' Union will entertain them at dinner. On Saturday, June 17, the Sections will meet in the morning (10 a.m.), and the concluding General Meeting will take place in the afternoon of the same day.